SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

REMEDIAL DESIGN PACKAGE

JUNE 2000

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT REMEDIAL DESIGN PACKAGE

TABLE OF CONTENTS

1 INTRODUCTION

2 DETAILED DESCRIPTION OF PROCESS OPERATIONS

2.1 PROCESS DESCRIPTION

2.2 PROCESS CONTROL PLAN

3 SAMPLING AND ANALYSIS PLAN

4 BERM EXCAVATION PLAN

5 OPERATIONAL ENVIRONMENTAL CONTROL PLAN

5.1 ENVIRONMENTAL ALARA REPORT

5.2 WASTE HANDLING WORK PLAN

5.3 ARAR COMPLIANCE MATRIX

6 HEALTH AND SAFETY CONTROLS

7 CONTINGENCY PLAN

8 SILO PENETRATION PLAN

APPENDICES

APPENDIX A – PROCESS FLOW DIAGRAMS
APPENDIX B – GENERAL ARRANGEMENT DRAWINGS
APPENDIX C – HEAT AND MATERIAL BALANCE
APPENDIX D – SYSTEM DESCRIPTION
APPENDIX E –SILOS PROJECTS ENVIRONMENTAL MONITORING PLAN
APPENDIX F – EASILY MANIPULATED MECHANICAL ARM (EMMA) INFO
APPENDIX G – PROCESS CONTROL PLAN (BALANCE OF PLANT)
APPENDIX H – PROCESS CONTROL PLAN (RADON CONTROL SYSTEM)
APPENDIX I – RESPONSES TO REGULATORY AGENCY COMMENTS

1.0 INTRODUCTION

The Silos 1 and 2 Accelerated Waste Retrieval (AWR) project is one of the initial steps in the remediation of Silos 1 and 2 within Operable unit 4 (OU4) at the Fernald Environmental Management Project (FEMP). A revised Feasibility Study/Proposed Plan for Silos 1 and 2 has been issued evaluating alternatives for treatment of the Silos 1 and 2 material. Following completion of the public involvement process, and subsequent issuance and approval of a Record of Decision (ROD) Amendment, a contract will be placed for implementation of the selected treatment remedy. The primary purpose of the AWR Project is to retrieve the material from Silos 1 and 2 and transfer it to a newly constructed Transfer Tank Area (TTA) for safe interim storage pending final treatment and disposal. The project also includes construction of a Radon Control System (RCS) to provide mitigation of radon emissions from the Silos, the TTA, and from the future Silos 1 and 2 Full-scale Remediation Facility. Fluor Fernald, Inc. has placed a contract with Foster Wheeler Environmental Corporation (FWENC) for the design, construction, startup, testing and operation of the systems and facilities required for implementation of the AWR Project

1.1 Purpose

The content of this Remedial Design (RD) Package is consistent with the *Silos 1 and 2 Accelerated Waste Retrieval Project Design Deliverables Schedule* which was submitted to the United States Environmental Protection Agency (USEPA) and the Ohio Environmental Protection Agency November 19, 1999. The intent of the RD package is to provide USEPA and OEPA with substantive information from the detailed engineering, design, and operations documentation. This information is to provide the Agencies with an understanding of the proposed design, retrieval, operation, and environmental controls necessary to ensure protection of the workers, public, health, safety, and the environment.

1.2 Scope

Site preparation construction activities for the AWR Project were detailed in the AWR Project Site Preparation Package. The Site Preparation Package was approved by the OEPA and the USEPA in May 2000. The work scope implemented under the approved Site Preparation Package was comprised of the following activities:

- Set up of office trailers and construction facilities
- Installation of erosion controls, storm water management facilities and temporary fencing
- Building of access roads and gravel parking areas
- Utility installation
- Site Grading and preparation of lay down areas
- Excavation, subgrade preparation, sump installation, and other preparation for foundations
- Placement of concrete mat foundations for the TTA, and RCS

This RD Package documents the remainder of the design for the AWR Project. The principle design elements detailed in the package include

- Design of the TTA
- Design of the RCS
- Design of the Silo Waste Retrieval System, including installation of the Silo superstructure
- Design of the Full-scale Mockup System at Silo 4
- Excavation and disposition of the Silo berm material in support of both the Silo superstructure installation and Silo waste retrieval operation
- Design of the Decant Sump Waste Retrieval and TTA Waste Retrieval Systems
- Characterization and disposition of secondary wastes generated during construction and operation activities
- Environmental controls for air emissions, wastewater, and storm water generated during construction and operation activities
- Sampling and analysis and process controls

The documents contained in the RD Package to address these design elements are described in the following sections.

Following receipt of U.S. EPA and OEPA approval of this RD Package, a Final Design Report will be prepared documenting the detailed, Certified for Construction (CFC) design. Any changes to the design will be documented, reviewed, and approved through a formal change control process. Design Change Notices (DCNs) documenting proposed changes which impact the approved RD package will be provided to OEPA and USEPA for review and approval.

1.3 Remedial Design Documentation

1.3.1 Detailed Description of Process Operations

1.3.1.1 Process Description

The Process Description document provides an overview of each of the systems that comprise the Accelerated Waste Retrieval process. The functions of these systems are to retrieve, transfer and store the K-65 residue for final remediation. Also these systems treat the radon and particulate emission. The systems consist of the following:

- Silo Waste Retrieval System (SWRS)
- Decant Waste Retrieval System (DWRS)
- Radon Control System (RCS)
- Transfer Tank Area (TTA)
- Full Scale Mock-Up System (FSMS)
- Transfer Tank Waste Retrieval System (TWRS)

The narrative descriptions presented in the document are intended to provide a guide to the more detailed information in the System Design Description and the PFD's.

1.3.1.2 Process Control Plan

The Process Control Plan describes the three control systems for the Easily Manipulated Mechanical Arm (EMMA), RCS, and balance of process systems. The Process Control Plan describes how these three control system interface and function.

1.3.2 Sampling and Analysis Plan

This plan describes the sampling and analysis effort associated with the AWR project. These efforts are summarized as followed:

- Ensure that the periodic discharge of excess water from the AWR project meets the waste acceptance (WAC) prior to being transferred to the site Advance Waste Water Treatment Facility.
- Ensure that the air emissions associated with the AWR project, meet the applicable regulatory and site standards; and
- Obtain archive samples from the TTA for future use by the Silo 1&2 final remediation project.

1.3.3 Berm Excavation Plan

This plan provides a summary of the construction and operational interfaces related to the excavation and removal of silo berm material. The Berm Excavation Plan emphasizes the excavation methods employed to mitigate the impact on silo structural integrity throughout the AWR project.

1.3.4 Operational Environmental Control Plan

The Operational Environmental Control Plan (ECP) describes the methods and controls that are to be incorporated into the design and operation of the Accelerated Waste Retrieval (AWR) Project to minimize the impacts of operation activities on the environment. These methods and controls are intended to minimize the environmental impacts of air emissions, dust, wastewater, storm water, erosion, and secondary waste generation resulting from AWR Project activities. Controls implemented to minimize the environmental impact of site preparation construction activities were documented in the Pre-operational Environmental Control Plan, submitted and approved as part of the AWR Project Site Preparation Package in May 2000.

Environmental ALARA Report

To support the evaluation of air emissions in the Environmental Control Plan, the Environmental ALARA Report provides a detailed analysis of projected radon emissions during each phase of the AWR project. Projected emissions of radon, the effectiveness of radon control provided by the RCS and the estimated impact of radon emissions on both onsite and offsite radon concentrations are evaluated for each of the following phases of the AWR Project:

- Phase 1 – Silo 1 and 2 headspace reduction
- Phase 2A – Silo 1 waste retrieval
- Phase 2B – Silo 2 waste retrieval
- Phase 2C – TTA ventilation

Waste Handling Work Plan

The Waste Handling Work Plan identifies the plans for management and disposition of each of the types of secondary waste generated during implementation of the AWR project. For each secondary waste stream, the Waste Handling Work Plan identifies the projected amount to be generated, anticipated characterization, and proposed disposition of the waste.

ARAR Compliance Summary

Applicable or Relevant and Appropriate Requirements (ARARs) and to-be-considered (TBC) requirements for the AWR Project were identified in the December 7, 1994, Record of Decision (ROD) for remedial actions at Operable Unit 4 (OU4) at the Fernald Environmental Management Project (FEMP). The ARARs Compliance Strategy identifies each ARAR and TBC requirement, the strategy used by the AWR Project to meet the requirement, and provides a cross-reference to the documentation within the RD Package where compliance with the ARAR is documented.

1.3.5 Description of Health and Safety Controls

The Health and Safety Control section describes the overall process for the development of the safety documentation for the AWR project. This section is an upper-tier summary that identifies the specific AWR documentation that details the preventative measures safety controls and action to be taken to mitigate the consequences of occupational, public and environmental hazards associated with the operational phase of the AWR project.

1.3.6 Contingency Plan

The Contingency Plan provides instruction for the AWR personnel in response to unusual and emergency events with the project area. The Contingency Plan is the interface document between the AWR project and the FEMP emergency organization, as identified in the FEMP Emergency Plan. The Contingency Plan describes the appropriate action for spill control, decontamination, emergency response and evacuation in the event of an unusual or emergency conditions.

1.3.7 Process Flow Diagrams

Appendix A contains the Process Flow Diagrams for all systems associated with the AWR Project.

1.3.8 General Arrangement Drawings

Appendix B contains the General Arrangement Drawings for all systems associated with the AWR Project.

1.3.9 Heat and Material Balance

Appendix C contains the Heat and Material Balance for all systems associated with the AWR Project.

1.3.10 System Description

Appendix D contains the System Description document. This document provides a detailed description of each system that supports the AWR project. This detail discussion defines the systems, the system functions and the interface between the systems.

1.3.11 Silo Penetration Plan

Section 8 contains the Silo Penetration Plan. This plan defines the methodology for safety making the silo penetrations to support silo waste retrieval activities. This plan defines the precautionary measures taken for worker, environmental, and public protection.

1.3.12 Silos Projects Environmental Monitoring Plan

The current focus of environmental monitoring at the Fernald Environmental Management Project is the implementation of site-wide environmental monitoring and project-specific environmental monitoring. Site-wide environmental monitoring is addressed in the Integrated Environmental Monitoring Plan (IEMP) while project-specific requirements are addressed within the environmental control plans, process control plans, and other design documents which constitute the project's remedial design package. For the Silo 3 Stabilization Project and the Silos 1 and 2 Accelerated Waste Retrieval Project (AWR Project), modifications to the site-wide environmental program are necessary to support project activities. Therefore, the focus of this plan is to establish the integrated environmental monitoring requirements for Operable Unit 4 (OU4) during the conduct of both projects.

Section 2.1
Process Desc.

REMEDIAL DESIGN PACKAGE
PROCESS DESCRIPTION

FOR THE

SILOS 1 & 2 ACCELERATED WASTE RETRIEVAL (AWR)
PROJECT

SUBMITTED TO:

FLUOR FERNALD, INC.

CONTRACT NO. FSC 624

ACRONYMS AND ABBREVIATIONS

AC	alternating current
ADSS	Arm Deployed Sluicing System
ALARA	as low as reasonably achievable
API	American Petroleum Institute
AWR	Accelerated Waste Retrieval
AWS	American Welding Society
AWWT	Advanced Wastewater Treatment
BRS	Bulk Retrieval System
CATS	Conditioning and Transfer System
CCTV	closed circuit television
CFC	Continuous Function Chart
Cfm	cubic feet per minute
CPU	central processor unit
DC	direct current
DCS	distributed control system
DIN	Deutsches Institute Normung
DOE	U.S. Department of Energy
DOF	degree of freedom
DRS	Debris Retrieval System
DWRS	Decant Waste Retrieval System
EDT	EMMA™ Deployment Tower
EMMA™	Easily Manipulated Mechanical Arm™
FDS	Facility Decontamination System
FEMP	Fernald Environmental Management Project
Fluor Fernald	Fluor Fernald, Inc.
Fps	feet per second
FSM	Full-Scale Mock-Up
FSMS	Full-Scale Mock-Up System
FSS	Fixative Spray System
GEE	Gripping End-Effector
GEES	Gripping End-Effector System
GFE	government-furnished equipment
Gpm	gallons per minute
HEPA	high efficiency particulate air
HMI	human-machine interface
Hp	horsepower
HVAC	heating, ventilating, and air conditioning
I/O	input/output
ICAT	Integrated Construction Acceptance Test
ISO	International Standards Organization
MEES	master equipment enable switch
MOV	motor-operated valves
NEMA	National Electrical Manufacturers Association
NIS	not in scope
NPSH	net positive suction head
PLC	programmable logic controller

ACRONYMS AND ABBREVIATIONS

PPE	personal protective equipment
Profibus	Process Field Bus
Psi	pounds per square inch
RH	relative humidity
RCS	Radon Control System
Rpm	revolutions per minute
SAIE	Silo-Arm Interface Enclosure
SDRS	Silo Debris Retrieval System
SFC	Sequence Function Chart
SOT	System Operability Test
SPSA	Sample Preparation and Storage Area
SREE	Silo Retrieval End-Effector
SSC	systems, structures, and components
SWRS	Silo Waste Retrieval System
TEFC	totally enclosed, fan-cooled
TRD	Technical Requirements Document
TTA	Transfer Tank Area
TWRS	Transfer Tank Area Waste Retrieval System
UF	ultra-filtration
UPS	Uninterruptible Power Supply
V	volt
VitPP	Vitrification Pilot Plant
WAC	waste acceptance criteria
WG	water gauge
WT%	weight percent

1.0 GENERAL OVERVIEW

1.1 Project Scope:

Silos 1 and 2 contain K-65 material, a residue that contains radionuclides, including radium (the primary radiological contaminant of concern), generated from the processing of high-grade uranium ores. The purpose of the Accelerated Waste Retrieval (AWR) Project is to retrieve the material from Silos 1 and 2, segregate discrete objects, and transfer the residue to transfer tanks for staging before final remediation. The project also includes the installation and operation of a Radon Control System (RCS) to reduce the radon concentration in each of the silos' headspace, and provide radon control during retrieval, material storage, and future operation of the final remediation facility. The final stage involves the gross decontamination of the silos, and equipment for system closure, and handle secondary waste generated during the AWR Project.

As the contractor, Foster Wheeler Environmental Corporation (FWENC) is designing, constructing, testing, and directing the operation and maintenance of the AWR Project. Fluor Fernald, Inc. is providing labor for operations and maintenance. The Project consists of five stages:

Stage 1: Radon Control System (RCS) Installation, Operation, and Maintenance to reduce the radon concentration of each of the silos headspace before construction around silos and silo retrieval operations;

Stage 2: Demonstration of the Full-Scale Mock-Up System (FSMS) and residue retrieval from the Transfer Tank Area (TTA) to support final remediation;

Stage 3: Residue material retrieval from the silos and decant sump tank, material segregation, transfer of residue to the TTA, and placement of discrete objects in drums for processing by others;

Stage 4: Staging and storage of the residue in the TTA; and

Stage 5: Perform gross decontamination and apply fixative to the silo interior structure. Also perform gross decontamination of the decant sump tank and contaminated process equipment.

1.2 Document Purpose:

The purpose of the Remedial Design Process Description document is to provide a summary description of the AWR process. Additional detail is provided in the FWENC System Design Description document contained in Appendix D of the Remedial Design Package. Also this document supports the AWR Remedial Design Process Control Plan included in the Remedial Design Package.

1.3 Systems Identification

The AWR Project includes seven major systems listed below and depicted in Exhibit 1-1.

Silos Waste Retrieval System (SWRS). The SWRS retrieves material from the silos; transfers residues, BentoGrout™, and heel material to the transfer tanks; retrieves and packages discrete objects; and performs gross decontamination of the silos.

Decant Sump Waste Retrieval System (DWRS). The DWRS retrieves materials from the decant sump (liquids from the silos and approximately 1,000 gallons of residue/solids in a heel), segregates and transfer/package material, and performs gross decontamination of the decant sump.

Transfer Tank Area (TTA). The TTA consists of transfer tanks to be used as a storage area for K-65 Material/BentoGrout™ slurry for future remediation activity. Provisions will be made for sampling and sample storage.

Transfer Tank Waste Retrieval System (TWRS). The TWRS will retrieve the K-65 Material/BentoGrout™ slurry from the TTA and transfer it for processing at a future waste treatment facility that is not in the scope (NIS) of the AWR Project.

Radon Control System (RCS), Phase 1 and 2. RCS Phase 1 controls and reduces radon concentrations in the silo headspace. RCS Phase 2 ensures radon control during retrieval, transfer, and storage of the silos material.

Full Scale Mock-Up System (FSMS). A Full-Scale Mock-Up Integrated Construction Acceptance Test (ICAT)/System Operability Test (SOT) is to be performed with the Silo 4 Full Scale Mock-Up System (FSMS). FWENC will incorporate the lessons learned from the FSM ICAT/SOT into the AWR Project before beginning operations and use the FSMS for training and troubleshooting during SWRS operations.

Facilities Decontamination System (FDS). The Facilities Decontamination System (FDS) (not shown in Exhibit 1-1) functions to remove gross contamination from the silos, the decant sump tank, and contaminated process equipment as part of facility demobilization and closure. Two categories of gross decontamination activities are provided by the FDS. First, the gross decontamination of silos, decant sump tank, and process equipment, as well as permanent facilities erected during the project is part of the FDS. The second type is decontamination of temporary tools, equipment, and facilities used on the project.

2.0 SILOS WASTE RETRIEVAL SYSTEM (SWRS)

2.1 Overview

The purpose of the Silos Waste Retrieval System is as follows:

- Bulk Material (K-65 residue and BentoGrout™) waste retrieval and transfer to the transfer tanks
- Heel material retrieval and transfer to the transfer tanks
- Discrete object retrieval and packaging

2.2 Bulk Retrieval System

The bulk retrieval system depicted on Exhibit 2-1 is a sluicing system based on past practices. The main components of the bulk retrieval system are as follows:

- Sluicer Module – contains sluicing nozzle, which is used to convert the silo contents into a slurry.
- Slurry Pump Module – pumps the slurry from the silos to the transfer tank area.

- Supernate Decant Pump Module – pumps the decanted supernate water from the transfer tanks to the sluicer module and slurry pump. The decanted supernate water is the main water supply for the sluicer module and slurry pump.

2.3 Bulk Waste Retrieval Strategy

The sluicing nozzle and the integrated slurry pump are used for sluicing the bentonite cap and K-65 waste material. Initially, the sluicing stream is directed as close to the pump inlet as possible to induce a small, localized slurry pool. Additionally, the slurry pump has the capability to operate in reverse, using sluice water, to assist in making a slurry pool. The slurry pump also has a high-pressure water jet ring at the pump suction, which can blast hard material into a pumpable slurry. The retrieval pump is designed to withstand occasional impact by the sluicing pump jet stream during operation. Upon creating the cavity, the sluicing nozzle cuts a canyon for slurry to flow though to the pump. The canyon will progress in depth and length toward the sluicer. The slurry pool size at the pump suction will be minimized to minimize free water in the silo. The sluicing will "push" the slurry towards the pump for retrieval. This type of operation occurs as long as it is effective. The width of the canyon will increase with priority being given to increasing the depth of the canyon, and the pump is periodically lowered (remotely) further into the tank, until it reaches the bottom. The sluicing nozzle is also lowered periodically further into the tank. If the sluicing nozzle is inadequate to break up a waste agglomeration, the EMMA™ assists the large sluicing nozzle with the small arm-based sluicing nozzle. This allows a focused stream to be applied close to the waste.

The waste stream is monitored to determine the point at which solids loading in the waste stream are the same as the return supply supernatant. Upon a determination that effective sluicing is complete, the pumping operation is modified to the Conditioning and Transfer System (CATS) mode. The bulk sluicing nozzle is retracted back into its containment housing above the silo on the platform.

To minimize the secondary waste water, the slurry water is supplied by a decant pump installed into the Transfer Tank. Section 4.0 will further describe the Transfer Tank system. The supernate water could also be processed through the ultra-filtration system for use by the high-pressure pumps for the heel removal and back flushing. In support of the silo waste retrieval activities, the silo berm will be lowered in stages as defined in the Berm Excavation Plan to minimize the load on the silo wall, and to ensure containment in the unlikely event of a failure of the silo walls, the level of the berm will be maintained at least five feet above the level of residue inside the silos.

Silo Waste Retrieval (SWRS)

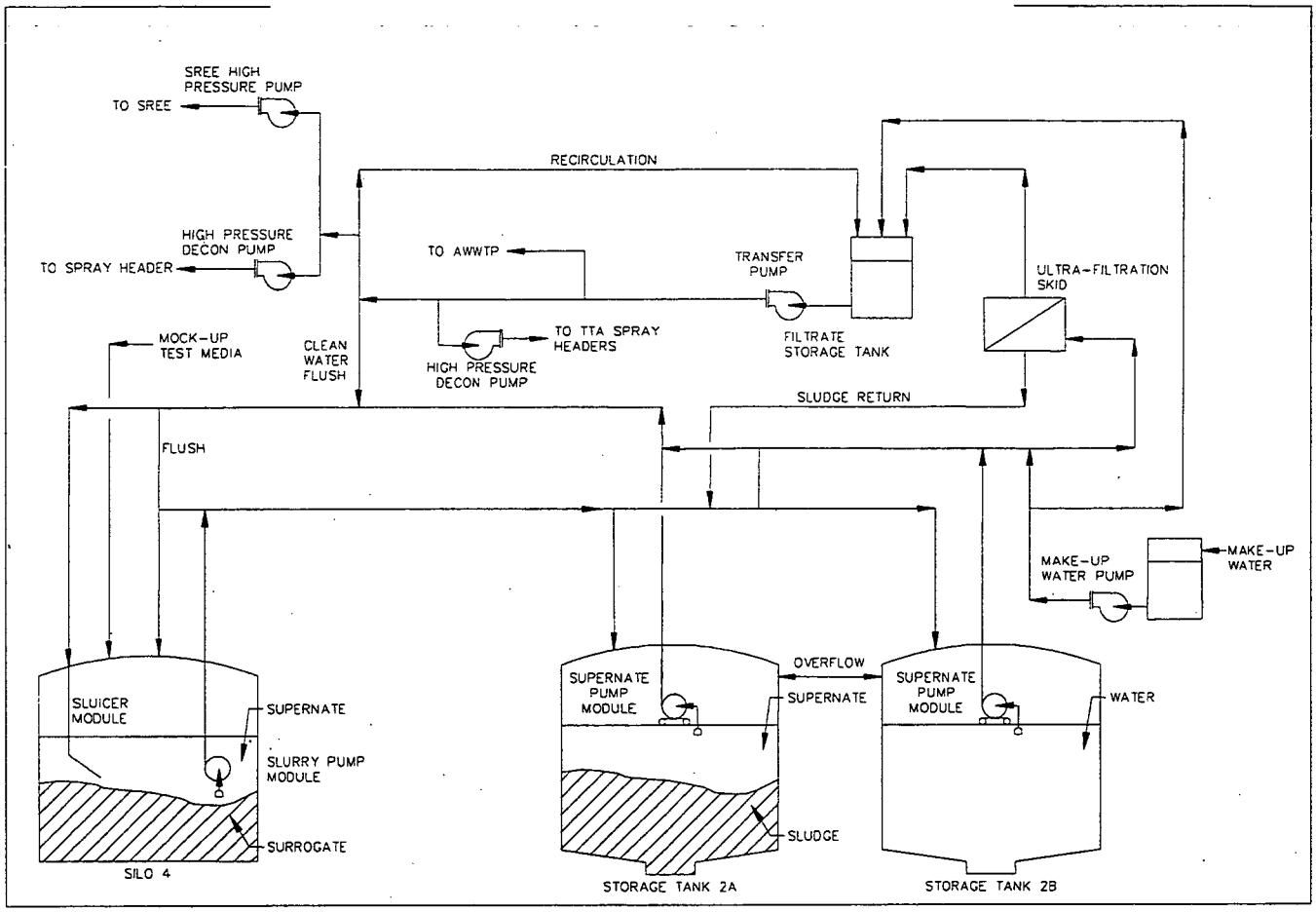

EXHIBIT 2-1

2.4 Heel Removal (Conditioning and Transfer) CAT System

Heel removal follows the bulk sluicing activities. The heel is defined as the slurry, supernate, and K-65 material located on the silo bottom left after the bulk sluicing. The heel removal operation as depicted on Exhibit 2-2 consists of the following major components:

- EMMA™ - EMMA™ is used to place the Silo Retrieval End Effector and other equipment in various locations where heel is present.
- Slurry Pump – Pump slurry from heel waste surge tank to the Transfer Tanks
- Silo Retrieval End Effector – The SREE consists of three rotating jets that are used to locally slurry material. The SREE jet nozzles operate at up to a maximum of 10,000 psi. Water to SREE comes from the SREE high-pressure pump.
- Jet Pump – Used to vacuum the slurry out of SREE and transfer the slurry to the heel waste surge tank.
- Heel Waste Surge Tank – located under the slurry pump to create a reservoir from which the slurry pump can operate.

Silo Waste Retrieval (CATS MODE)

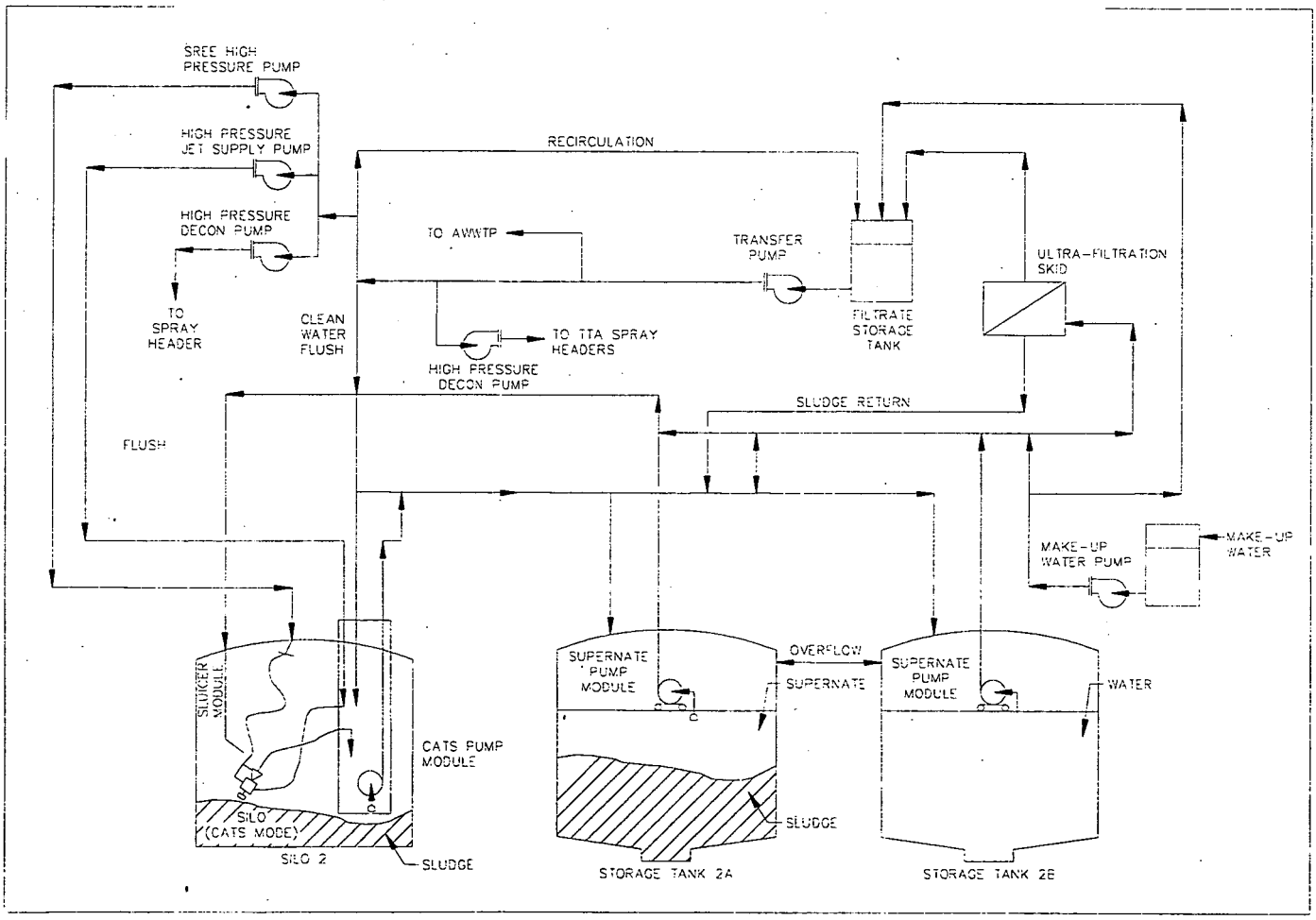

EXHIBIT 2-2

2.5 Heel Removal Strategy

The CATs system is lowered to the silo floor from one of the enlarged manways by a hoist. Then the EMMA™ grasps and maneuvers the SREE in the tank to where heel is present.

When the SREE inlet is placed over heel and submerged in liquid, the jet pump can remove up to 100 gallons per minute of motive water and liquid. When the inlet begins to pump air, the overall retrieval rate is decreased significantly. However, the system is able to continue to vacuum the bottom of the silo floor. Both the SREE and the jet pump require filtered water for the small nozzles that are used. Filtered water is supplied by the ultrafiltration system. The slurry from the SREE inlet port is sucked into the three jets and it is pressurized and "pushed" through the jet pump discharge nozzle and into the Heel Waste Surge Tank that is located as close to the floor as possible. The slurry in the Heel Waste Surge Tank is then pumped by the slurry pump to the Transfer Tank.

2.6 Debris Removal

A simple basket system design allows the debris that remains at the bottom of the tank to be removed and packaged for disposal. The basket is lowered through the same riser that the sluicing nozzle is deployed. The basket is lowered from the containment housing at the top of the platform by a cable and winch system. EMMA™ uses the gripper to collect and place debris into the basket until the basket is either full or all the reachable debris has been placed into the basket. The basket is raised back into the containment housing where it is placed in a drum to allow for removal from the platform and disposition by Fluor Fernald, Inc.

2.7 Waste Retrieval Support

The EMMA™ is used to support all activities within the Silos. EMMA™ features include:

- Deploying the high-pressure Arm Deployed Sluicing System (ADSS) nozzles to mobilize the BentoGrout™ layer and force the dislodged material toward the slurry pump;
- Forcing the waste and debris away from the sluicing pump and Silo Retrieval End-Effector (SREE) to facilitate continuous operations;
- Supporting the camera and lighting system, inspection and cleaning of all wall-mounted silo sampling ports;
- Cleaning the in-silo cameras and lights to ensure optimum visibility for remote operations;
- Transferring debris to different locations in the silo before removal to minimize retrieval obstructions;
- Mobilizing bulk waste and debris from behind the sluicing pump and water cannon;
- Performing wall washing and inspection operations as the headroom within the silo is increased (eliminates need for high-pressure water cannon on walls and minimizes the potential for silo damage caused by high-pressure wall washing activities);
- Forming debris piles for size reduction and removal activities;
- Strategically placing the debris size reduction tool off-center from the riser location near debris piles and providing a flat surface under the silo riser for placement of the debris collection and transport basket;
- Transferring debris from the pile to the size reduction tool to the retrieval basket;
- Providing close visual inspection capabilities throughout operations and final inspection;

- Employing the ADSS for fixative application; and
- Employing the Gripper End-Effector System (GEES) camera and lighting system to assist in initial and final wall, floor, and ceiling inspection activities.

.0 Decant Sump Waste Retrieval System

The Decant Sump Waste Retrieval System (DWRS) will retrieve the waste from the Decant Sump located within the silo area. In support of silo bulk retrieval a submersible pump with level indicator will be lowered into the Decant Sump Tank. If the decant sump level rises during the Silo Waste Retrieval System operation, a tanker truck will be mobilized and the liquid will be pumped from the Decant Sump into the tanker truck, sampled, analyzed, and dispositioned.

After the Silo Waste Retrieval is complete, the sluicer from SWRS will be modified and used with a jet pump for slurrying the Decant Sump Tank waste to the TTA using the supernate decant pump for sluicing supply water just like the SWRS operation.

4.0 Transfer Tank Area (TTA)

The TTA System is provided to store residues received from Silos 1 and 2, and the Decant Sump. The TTA consists of a building that provides shielding and containment for the Transfer Storage Tanks, a residue sampling system, a water makeup system, a water elimination system, and a piping network for receiving and transferring residues from the silos to a future remediation facility. The TTA communicates with and supports the following systems:

- Silo Waste Retrieval System (SWRS)
- Decant Waste Retrieval System (DWRS)
- TTA Waste Retrieval System (TWRS)
- Full Scale Mock-Up System (FSMS), and
- Radon Control System (RCS).

4.1 SWRS and DWRS Support

The TTA System supports SWRS and DWRS by receiving the slurry from the waste retrieval activity into the transfer storage tank. The slurry waste will settle and the supernate will be decanted and used as sluice water supply. The system is designed to allow the slurry feed tank and sluice water supply tank to change roles to allow for settling and minimize water usage.

During heel removal activities the CATS mode is utilized. The CATS mode requires high-pressure water that is provided by the high-pressure pumps located near the bridge. The supply to the high-pressure pumps is from the TTA Filtrate Transfer Pumps that transfer water from the TTA Filtrate Storage Tank. Level in the TTA Filtrate Storage Tank is maintained by water transferred from the sluice water header from the Ultra-Filtration Unit. Makeup water for the TTA Filtrate Storage Tank is also available from the Makeup Water Tank. The slurry from heel removal is transferred to Transfer Storage Tank for settling and decanting. The sluice water is supplied from a Transfer Storage Tank where the settling activity is complete and supernate is available.

4.2 FSMS Support

The TTA System supports the Full Scale Mock-Up System (FSMS) in the same manner as the SWRS, TWRS because the FSMS is the system that will test the SWRS and TWRS equipment with surrogate material prior to the Silos 1&2 waste retrieval activities.

4.3 TWRS Support

During the operation of the TWRS, the K-65/BentoGrout™ is slurried from the TTA tanks to the remediation facility in a similar fashion as it was removed from the silos except two sluicing nozzles are deployed in the storage tank being emptied, and the CATS system and EMMA™ are not required. The storage tank bottoms are sloped to a center sump to facilitate heel removal. The Slurry Pump is deployed in the center tank nozzle. When one tank is completely emptied, instrumentation, cameras, pumps, and sluicers are moved to the next tank. The operation is repeated until all four tanks are emptied.

4.4 Radon Control System (RCS) Interface

The Transfer Storage Tanks are vented to the RCS to control the build-up of radon in the tanks.

4.5 Sampling System

After the slurry waste has settled, samples will be taken and archived to support the final remediation treatment development. These samples will be taken using a mobile percussion hammer-coring machine which will be operated from a portable enclosure located on the TTA equipment deck. This methodology involves a dual tube sampling system for extracting samples from the TTA Transfer Storage Tanks. The samples will be placed in 5-gallon pails and stored in 55-gallon drums. The 55-gallon drums of samples will be stored on the TTA equipment deck.

4.6 Transfer Storage Tanks

Four Transfer Storage Tanks are provided for storage of residues from Silos 1 and 2, and from the silos Decant Sump. The K-65 material and BentoGrout™ from Silo 1 are stored in two of the four tanks, and the K-65 material and BentoGrout™ from Silo 2 is stored in the other two tanks. The residue in the Decant Sump is transferred to the storage tanks assigned for receipt of wastes from Silo 2.

The carbon steel Transfer Storage Tanks each have a capacity of 750,000 gallons and are constructed in accordance with American Petroleum Institute API-650. The tank volume was selected to allow for a maximum storage level of 90% of total capacity, although the tanks are designed for filling to their maximum capacity. The tanks are 66-feet in diameter, have a straight side dimension of 30 feet, and are provided with 1/4-inch corrosion allowance. The exterior surfaces of the tanks are painted. The tank roofs are dome shaped and are supported by rafters to minimize the overall height to 33-feet, 6-inches (excluding nozzle risers) from the top of their concrete foundations. The tank bottoms are sloped to a center sump to facilitate residue removal during TWRS.

5.0 Transfer Tank Waste Retrieval System (TWRS)

The TWRS as depicted in Exhibit 5-1 is designed to access, mobilize, and transfer residue stored in the TTA System. The TWRS is comprised of the TTA System and support features included within the future remediation facility. Sluicers, Slurry Pumps and equipment used for the SWRS are also deployed for the TWRS.

The function of the TWRS is to provide the capability to retrieve and transfer the entire inventory of waste from the TTA Transfer Storage Tanks (TTA tanks) to a future remediation facility for final treatment and disposal. The same equipment used for the SWRS will also be deployed by the TWRS with one major design enhancement. The TTA tanks will have two opposing sluicer assemblies per tank with a central slurry pump, thereby eliminating the need for heel removal. All of the equipment will be of the same design and fully interchangeable. Thereby, the sluicer assembly used in the silos will be the same as the sluicer assembly used in the TTA tanks. The two-sluicer assemblies and the central slurry pump will permit a "swirl" movement of the waste within the tank as the waste is removed. This will result in providing a more uniform mix of waste material.

Equipment is provided for the transfer of stored residues from one TTA tank at a time. Diverter valves with flange connection are provided for connecting slurry and sluice water piping to and from the future remediation facility using the existing decant pumps. Sluice water for TWRS operations is supplied from the future remediation facility using the same settle and decant approach. The TTA System provides piping and valves between the future remediation facility interface point and each of the four TTA tanks. The two Sluicer modules and the Slurry Pump module are connected to the storage tank being emptied.

Transfer Tank Waste Retrieval System (TWRS)

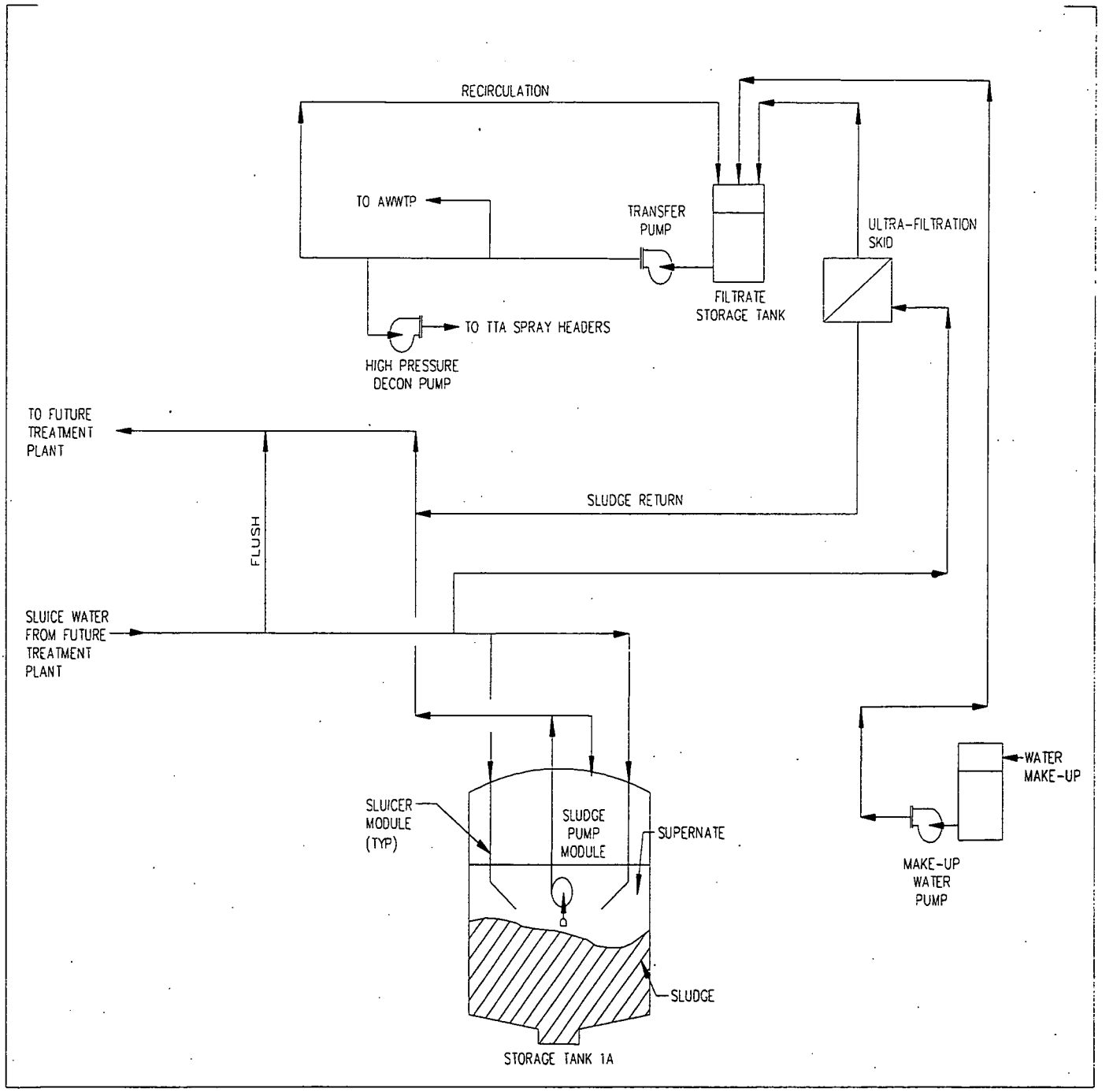

EXHIBIT 5-1

6.0 Radon Control System (RCS) (Phase 1 and Phase 2)

The RCS as depicted in Exhibit 6-1 is a treatment system that employs air conditioning, dehumidification, activated carbon, and HEPA filtration to control and monitor emission of radon and other contaminants. The RCS System receives gas streams from the following sources:

- Silo 1 and Silo 2
- Silo Waste Retrieval System
- Decant Sump Waste Retrieval System
- TTA System
- Transfer Tank Area Waste Retrieval System, and
- Final Remediation Facility

The RCS is operated in two phases. Phase 1 is a recycle loop used to treat the Silo 1 and 2 radon concentration prior to any activity on or near the silos. Phase 2 of the RCS is a once-through system to support the waste retrieval activities.

The RCS is designed to remove radon-laden air from the various system components, reduce radon releases to the atmosphere, detect and measure releases to the atmosphere, and mitigate system upsets. Contaminated gases removed from the sources described above are drawn through the RCS by redundant centrifugal fans (FAN-20-001A and FAN-20-001B). The fans and ducting system are designed to prevent over or under pressurization of the silos and transfer tanks beyond +0.5 inch water gauge (WG) and −2.0 inch WG. The ducting system recirculates process air through the system or discharges through the exhaust stack, while maintaining the required silo and tank pressures. The ducting system is balanced using a redundant programmable logic control (PLC) system. The fans are located downstream of the carbon beds to maintain an induced draft in the carbon beds. The ducting arrangement, in conjunction with the automated monitoring and damping system, prevents backflow of contaminated gases to the atmosphere.

The total design flowrate for the RCS is 1,000 cubic feet per minute (cfm). The ventilation rate for each source listed above is dependent upon which operational phase is in effect for the RCS. The ventilation gas from each source is withdrawn and transferred to the RCS Building where the treatment equipment is located. Ventilation air from each source is combined into a 10-inch insulated, carbon steel, common duct header. The 10-inch header connects to redundant 95%-efficient roughing filters (FLT-20-001A and FLT-20-001B) for particulate removal. Filters will be operated with one online at a time dependent upon which train is in operation.

Upon exiting a roughing filter, the ventilation air enters one of the redundant desiccant drying systems (DDS-20-001A and DDS-20-001B) at 90° F and 100% relative humidity (RH) where the air stream is cooled and dehumidified to 36°F and 15% RH. The gas is cooled and dehumidified to enhance the dynamic adsorption capacity of the activated carbon. A condensate pump located within the desiccant drying system transfers condensed liquids from the desiccant drying system to one of two 3,000-gallon carbon steel hold-up tanks (TNK-20-002A and TNK-20-002B). The condensate holdup storage tanks are vented to the RCS and automatic dampers will open to relieve pressure. These tanks are equipped with vacuum control valves to let air into tanks when vacuum setpoint is reached. The liquid is held for as much as 40 days in the condensate holdup tanks to allow for radon decay. Subsequently, transfer pumps disposition the liquid in one of two ways:

- Transfer to the filtrate tanks in the TTA building for subsequent distribution to one of the four Transfer Storage Tanks or use by the high-pressure pumps.
- Transfer to the FEMP Advanced Wastewater Treatment (AWWT) facility after characterization indicates the condensate meets the waste acceptance criteria (WAC).

The chilled/dehumidified ventilation air stream exiting the desiccant drying systems flows to the carbon adsorption units (CBD-20-001A, CBD-20-001B, CBD-20-002A, and CBD-20-002B) via a 10-inch carbon steel duct header. The carbon adsorption system consists of four insulated carbon steel vessels, approximately 16-feet by 11-feet by 11-feet, which contains a total of 160,000 pounds of carbon (40,000 pounds per vessel). The four carbon beds are operated in parallel splitting the flow equally. Each carbon bed is connected to the 10-inch main duct headers by 8-inch branch duct connections on both the inlet and outlet of the beds. Each bed is aligned with a dedicated inlet and outlet damper for flow control and isolation. Modulating dampers and flow elements provided on the inlet of each bed allow flow to each bed to be reduced or increased on the basis of operations. Each carbon adsorption vessel is capable of treating up to 500 cfm.

The treated gas stream flows from the carbon adsorption units through 8-inch branch connections to the 10-inch duct header to the redundant high-efficiency particulate air (HEPA) filtration units (FLT-20-002A and FLT-20-002B). Filters will be rated at 1,000 cfm each and operated with one online at a time. Air from the carbon beds, makeup air, and fan recycle combine before entering the HEPA filters.

Quantities of makeup air, fan recycle air, and stack exhaust will be based upon maintaining a certain static pressure at the discharge of the fan. These flows will be closely controlled so that the air discharged to the exhaust stack will be minimized to maintain the appropriate negative pressure and flow through the system. After exiting the operating HEPA filter unit the treated air stream enters the operating recirculation fans (FAN-20-001A and FAN-20-001B) for redistribution to the silos, TTA tanks, or exhaust through the monitored stack (STK-20-001).

The stack (STK-20-001) is a 150-foot tapered carbon steel stack that is approximately 6 feet 4 inches at the base and tapers to approximately 3 feet at the top. The maximum airflow through the stack is 12,000 cfm. The stack has connections for a 10-inch carbon steel RCS process duct and a 34-inch carbon steel building ventilation duct. The stack is provided with an isokinetic sampling system and will include monitoring for both particulate radionuclides and continuous monitoring for radon.

Radon Control System (RCS)

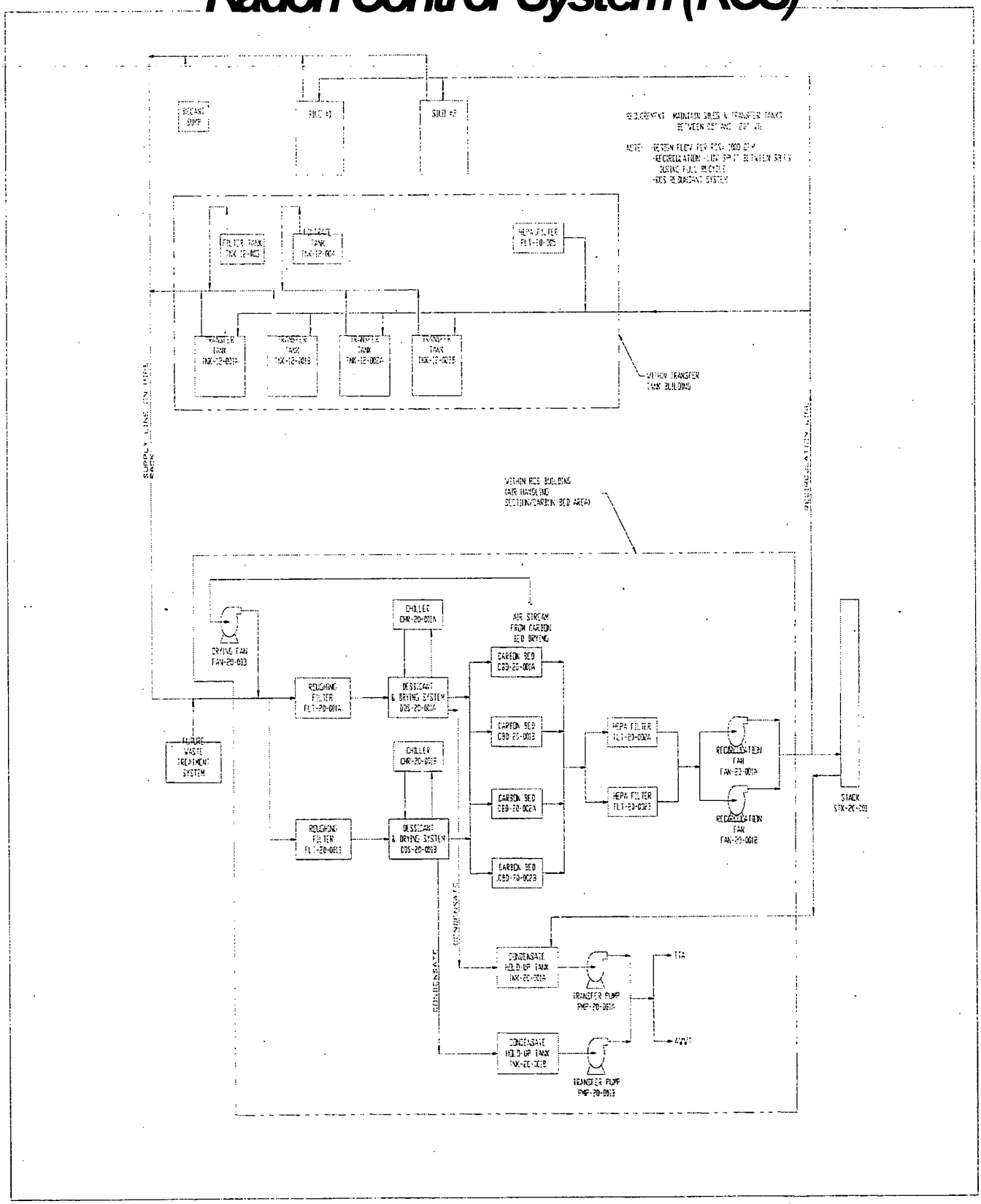

EXHIBIT 6-1

7.0 Full-Scale Mock-Up System (FSMS)

The Full-Scale Mock-Up System (FSMS) is designed to provide the equipment at Silo 4 for the operator training and proof of principle testing of the following AWR systems. This testing includes the removal and transfer of K-65 silo surrogate material and debris. The testing will be performed in a nonradioactive environment using Silo 4 and modified Silo 4 superstructure facilities. FSMS refers to the specific systems, structures, and components (SSCs) that are installed at the Silo 4 facility. Full-Scale Mock-Up (FSM) refers to the integrated overall AWR mockup system including the FSMS. The FSMS tie-ins to the AWR system will be removed at the completion of the FSM Integrated Construction Acceptance Test (ICAT) and System Operability Test (SOT). The FSMS will remain as a stand-alone system ensuring continued availability for training, system optimization and troubleshooting throughout the AWR operations phase. The FSMS will utilize the exact model of equipment used in the SWRS, TWRS, and TTA to gain the most accurate testing and training.

To more closely represent the Silo 1 and 2 Waste Retrieval activities a tank will be installed in Silo 4. This tank will be under all three manways and extend to the Silo wall for heel.

8.0 Facilities Decontaminated System (FDS)

The Facilities Decontaminated System (FDS) removes gross contamination from the silos, the decant sump tank, and contaminated process equipment as part of facility demobilization and closure. The FDS offers two categories of gross decontamination activities. First, the FDS provides gross decontamination of silos, decant sump tank and process equipment, as well as permanent facilities erected during the project, especially those left behind for management of the waste and radon effluent until the time that the waste is remediated. The second type of gross decontamination that the FDS provides is the processing of temporary tools, equipment, and facilities used on the project.

8.1 Silos Decontamination and Fixative Application

Gross decontamination of permanent facilities includes decontamination of the internal surfaces of the silos. The Fixative Spray System (FSS) is used after the internal surfaces of the silos are accessed and decontaminated to remove all visible loose contamination, as verified by closed-circuit television (CCTV) inspection. The FSS applies a fixative to the walls and floors of the silos after completion of waste and debris removal to prevent any radionuclides in the concrete surfaces from becoming airborne. The fixative is a water-based, paint-like liquid material that has properties that allows it to contain radioactive contamination under the fixative layer after it dries. More than one layer of fixative may be applied as necessary to achieve the necessary level of sealing of the silo walls. The FSS consists of pump, hose, nozzle, and small, positive-displacement pump and uses EMMA™ to reach all points within the silos.

8.2 Decontamination, Packaging, and Staging of Contaminated Materials

Waste generated in the decontamination of temporary equipment and facilities consist primarily of wiping materials, water, and contaminated grit if abrasive blasting is needed to clear parts. These materials are packaged and disposed of as radioactive waste.

Decontamination of discrete objects and failed equipment will be performed in a portable, truck-mounted decontamination facility. It provides for cleaning of equipment as large as 18-feet x 30-feet and the collection of water and abrasive cleaning media used in the cleaning process. The survey of material for unrestricted release (that precedes making the material available to Fluor Fernald, Inc. for verification survey) is done in an area within a facility reserved for this function where background radiation level is low enough to achieve the desired instrument sensitivity. This facility is located in the southwest section of the project site. An equivalent facility is provided for the Fluor Fernald, Inc. verification.

9.0 Easily Manipulated Mechanical Arm (EMMA™) System

The EMMA™ System is a major component of the Silo Waste Retrieval System (SWRS), and is critical to the success of the Accelerated Waste Retrieval (AWR) program. Two systems are planned for delivery to the Fernald site. These systems will be used for the AWR operations on Silos 1 and 2, and the Full-Scale Mock-Up (FSM) testing activities planned for Silo 4.

The EMMA™ System is designed to assist in all mining and silo closure operations for BentoGrout™ removal through final inspection and fixative application activities. The proposed mining strategy will be achieved through effective employment of the EMMA™. The EMMA™ will facilitate operations from initial entrance into the silo through final clean out, inspection, and closure acceptance. Waste and debris retrieval operations using the EMMA™ System is achieved by:

- Deploying the high-pressure Arm Deployed Sluicing System (ADSS) nozzles to mobilize the BentoGrout™ layer and force the dislodged material toward the sluicing pump;
- Forcing the waste and debris away from the sluicing pump and Silo Retrieval End-Effector (SREE) to facilitate continuous operations;
- Support the camera and lighting systems, inspection and cleaning of all wall-mounted silo sampling ports;
- Cleaning the in-silo cameras and lights to ensure optimum visibility for remote operations;
- Transferring debris to different locations in the silo before removal to minimize retrieval obstructions;
- Mobilizing bulk waste and debris from behind the sluicing pump and water cannon;
- Performing wall washing and inspection operations as the headroom within the silo is increased (eliminates need for high-pressure water cannon on walls and minimizes the potential for silo damage caused by high-pressure wall washing activities);
- Forming debris piles for size reduction and removal activities;
- Strategically placing the debris size reduction tool off-center from the riser location near debris piles and providing a flat surface under the silo riser for placement of the debris collection and transport basket;
- Transferring debris from the pile to the size reduction tool to the retrieval basket;
- Providing close visual inspection capabilities throughout operations and final inspection;
- Employing the ADSS for fixative application, and
- Employing the Gripper End-Effector System (GEES) camera and lighting system to assist in initial and final wall, floor, and ceiling inspection activities.

10.0 Process Control

Process Control of the RCS, EMMA™, Waste Retrieval activities will be accomplished by three distributed control systems at HMI stations in the control trailer. The Process Control Plan will provide further discussion on these controls.

11.0 Silo Penetration

To deploy the various equipment and system into the Silos the existing manways need to be enlarged. The Silo Penetration Plan will provide further discussion on how the Silo Penetration activity is done.

Section 2.2
Process Control Plan

Accelerated Waste Retrieval Project Process Control Summary

1.0 INTRODUCTION

1.1 Objective

The objective of this document is to provide a general overview of the Accelerated Waste Retrieval Project controls, operating parameters, and alarms. The Accelerated Waste Retrieval process control systems are designed to support the treatment of radon, waste retrieval, full-scale mock-up testing and staging of waste in the TTA.

1.2 Overview

The AWR project consists of several separate phases and activities that require different process controls. The AWR Radon Control System is required to operate continually throughout the waste retrieval operation, prior to any construction activities around and on the silos and during the staging of silo material in the TTA tanks. The silo waste retrieval activities are batch processes and requires controls to start, stop and periodically control operation. To accomplish these multiple functions and activities the AWR Process Control Philosophy is to use three independent control systems. These systems are as follows:

- Balance of Plant (BOP) Control System
- Radon Control System (RCS) Control System
- Easily Manipulated Mechanical Arm (EMMA) Control System

The three independent control systems are integrated through a fiber optic cable link and the Siemans Profibus operating system. The primary plant operating system is the BOP Control System, which is responsible for total control of plant operations with exception of the RCS and EMMA systems. The RCS and EMMA systems are provided with independent control systems and do not directly communicate with each other except through their common link to the BOP Control System as depicted in Exhibit 1-1.

The BOP Control System does not provide control input signals to either the EMMA or RCS control systems but it does receive and log status and alarm signals from both the RCS and EMMA control systems. In the case of alarm or status signal requiring action from the RCS or EMMA control system the operator will need to operate the appropriate HMI and take the necessary action.

CONTROL INTERFACE DIAGRAM

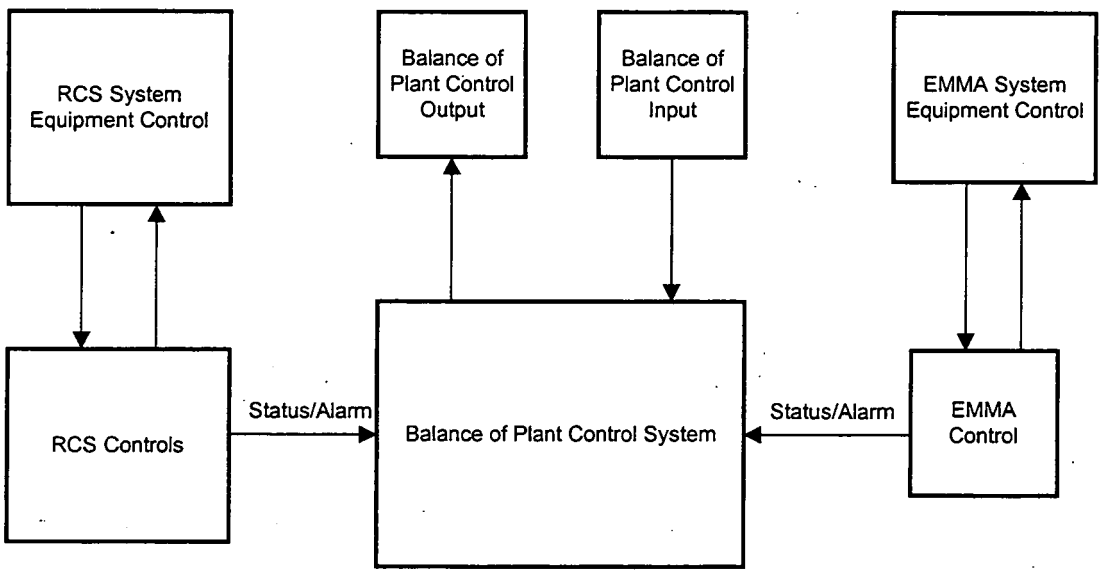

EXHIBIT 1-1

2.0 Control System Descriptions

2.1 Balance of Plant Control System

The BOP Control System controls all plant operations except the RCS and EMMA operations. It includes PLC controls and redundant HMI consoles for the K-65 conveyance and storage system, water supply, and the filtration system. The HMI consoles are located in the AWR Project control trailer and are capable of accessing status and alarm information from the RCS and EMMA systems. Each subsystem in the BOP can be operated locally through the PLC with safety interlocks to prevent inadvertent operation of equipment. The BOP Control System provides several key operational control functions as noted in the Process Control Key Parameters/Set-point Table Exhibit 2-1. Specifically the BOP control system is responsible for controlling the flow rates, operating pressures and solids concentrations during sluicing operations. Details of the Balance of Plant (BOP) Process Control philosophy are included in Appendix H Process Control Plan of the Balance of Plant. This appendix includes detailed discussion of control sequences, alarm responses, and auto and manual control features.

2.2 RCS Control System

The RCS Control System controls the operation of the Radon Control System. The RCS control system is provided with redundant PLC controls and HMI consoles to ensure continuous operation. One of the HMI stations is located in the Electrical Building. The second HMI is located in the AWR Project control trailer. This additional HMI provides redundancy for data, control, and archiving information. The RCS system is also provided emergency notification by a phone call box should a device fail or system upset. The control system automatically switches to the redundant device and re-aligns the train to maintain operation. The RCS system also provides hard-wired E-stop signals to the other systems should the RCS system shutdown. Instrument inputs to the system are ranged by the PLC to engineering units and critical information is logged and archived during operations.

The critical control parameters controlled by the RCS are listed in the Process Control Key Parameters/Set-point Table Exhibit 2-1. The key functions of the RCS Control system are as follows;

- To monitor the flow rate, radon concentration, particulate concentration and radioactivity of the air stream discharged from the RCS

- To control the silo air flow and pressure
- To monitor the temperature and relative humidity of the gas which passes through the carbon beds and the gas flow rate through each respective carbon bed.

These key parameters are continuously monitored and logged. The system is designed to alarm and automatically switch to a no discharge/total recycle mode of operation when excessive radon or radioactivity is sensed in the discharge.

Details of the Radon Control System Process Control philosophy are included in Appendix I Process Control Plan of the Radon Control System. This appendix includes detailed discussion of control sequences alarm responses and auto and manual control features.

2.3 EMMA Control System

The EMMA Control system is used to control the EMMA manipulator system. The EMMA system is normally operated using the HMI located in the AWR Project control trailer. Should a need arise the EMMA may also be operated at the local HMI located at the EMMA tower. The EMMA Control System is responsible for the complete operation of the EMMA arm. The control system continuously maps and logs the position and speed of the arm as well as being responsible for all arm movement.

The key control parameters controlled by the EMMA Controller are listed in the Process Control Key Parameters/Set-point Table Exhibit 2-1.

Details of the EMMA Process Control philosophy are included in Appendix G EMMA System Description. This appendix includes detailed discussion of control sequences alarm responses and auto and manual control features.

PROCESS CONTROL KEY PAR_ _TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
PDIT-SILO-20-002	MONITOR AND CONTROL SILO PRESSURE	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint: System shutdown on unrelieved pressure conditions	20FMD012
FE/FIT-SILO-20-001	MONITOR FLOW FROM SILO 1	0-1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from silo	20FMD013
FE/FIT-SILO-20-002	MONITOR FLOW FROM SILO 2	0-1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from silo	20FMD013
LVR-20-001	CONTROL SILO PRESSURE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD013
LVR-20-002	CONTROL SILO PRESSURE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD013
LVR-20-003	CONTROL SILO PRESSURE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD013
LVR-20-004	CONTROL SILO PRESSURE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD013
PDIT-SILO-20-001	MONITOR AND CONTROL SILO PRESSURE	-5 TO 5" W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint:System shutdown on unrelieved pressure conditions	20FMD013
FE/FIT-CBD-20-001A	CONTROL FLOW ACROSS CARBON BED 1A	0 TO 1000 ACFM	100 ACFM	500 ACFM	YES	Supply damper modulation to alleviate reduction in bed performance or bed isolation by closing exhaust damper on bed	20FMD016
FE/FIT-CBD-20-001B	CONTROL FLOW ACROSS CARBON BED 1B	0 TO 1000 ACFM	100 ACFM	500 ACFM	YES	Supply damper modulation to alleviate reduction in bed performance or bed isolation by closing exhaust damper on bed	20FMD016
FE/FIT-CBD-20-002A	CONTROL FLOW ACROSS CARBON BED 2A	0 TO 1000 ACFM	100 ACFM	500 ACFM	YES	Supply damper modulation to alleviate reduction in bed performance or bed isolation by closing exhaust damper on bed	20FMD016
FE/FIT-CBD-20-002B	CONTROL FLOW ACROSS CARBON BED 2B	0 TO 1000 ACFM	100 ACFM	500 ACFM	YES	Supply damper modulation to alleviate reduction in bed performance or bed isolation by closing exhaust damper on bed	20FMD016
LVR-20-005	MODULATES FLOW THOUGH CARBON BED 2B	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by individual radon monitor	20FMD016
LVR-20-006	MODULATES FLOW THOUGH CARBON BED 2A	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by individual radon monitor	20FMD016
LVR-20-017	MODULATES FLOW THOUGH CARBON BED 1A	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by individual radon monitor	20FMD016
LVR-20-021	MODULATES FLOW THOUGH CARBON BED 1B	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by individual radon monitor	20FMD016
ME/MT-CBD-20-001	MONITORS MOISTURE PRIOR TO CARBON BEDS	0 TO 100% RH	N/A	15%	YES	Changeover of operating train	20FMD016
ME/MT-CBD-20-002	MONITORS MOISTURE AFTER CARBON BEDS	0 TO 100% RH	N/A	N/A	N/A	Moisture loading on bed	20FMD016
PDIT-CBD-20-001A	INDICATING DIFFERENTIAL PRESSURE ACROSS CARBON BED 1A	0 TO 20" W.G.	4" W.G.	15" W.G.	YES	Indicates reduced airflow and alerts operation of possible problems	20FMD016

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PROCESS CONTROL KEY PA[illegible]TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
PDIT-CBD-20-001B	INDICATING DIFFERENTIAL PRESSURE ACROSS CARBON BED 1B	0 TO 20" W.G.	4" W.G.	15" W.G.	YES	Indicates reduced airflow and alerts operation of possible problems	20FMD016
PDIT-CBD-20-002A	INDICATING DIFFERENTIAL PRESSURE ACROSS CARBON BED 2A	0 TO 20" W.G.	4" W.G.	15" W.G.	YES	Indicates reduced airflow and alerts operation of possible problems	20FMD016
PDIT-CBD-20-002B	INDICATING DIFFERENTIAL PRESSURE ACROSS CARBON BED 2B	0 TO 20" W.G.	4" W.G.	15" W.G.	YES	Indicates reduced airflow and alerts operation of possible problems	20FMD016
RE/RQIT-CBD-20-001A	MONITORS RADIATION BREAKTHOUGH OF CARBON	0 TO 1,000,000 pCi/L	N/A	H-130,000 pCi/L HH-250,000 pCi/L	YES	Redistribution of air flow upon high alarm: bed shutdown on high/high alarm Adjustable over	20FMD016
RE/RQIT-CBD-20-001B	MONITORS RADIATION BREAKTHOUGH OF CARBON BED 1B	0 TO 1,000,000 pCi/L	N/A	H-130,000 pCi/L HH-250,000 pCi/L	YES	Redistribution of air flow upon high alarm: bed shutdown on high/high alarm Adjustable over operating phases	20FMD016
RE/RQIT-CBD-20-002B	MONITORS RADIATION BREAKTHOUGH OF CARBON BED 2A	0 TO 1,000,000 pCi/L	N/A	H-130,000 pCi/L HH-250,000 pCi/L	YES	Redistribution of air flow upon high alarm: bed shutdown on high/high alarm Adjustable over operating phases	20FMD016
RERQIT-CBD-20-002A	MONITORS RADIATION BREAKTHOUGH OF CARBON BED 2B	0 TO 1,000,000 pCi/L	N/A	H-130,000 pCi/L HH-250,000 pCi/L	YES	Redistribution of air flow upon high alarm: bed shutdown on high/high alarm Adjustable over operating phases	20FMD016
TE/TT-CBD-20-001	MONITORS TEMPERATURE ENTERING CARBON BEDS	0 TO 100°F	N/A	40F	YES	Changeover of operating train	20FMD016
TE/TT-CBD-20-002	MONITORS TEMPERATURE EXITING CARBON BEDS	0 TO 100°F	N/A	40F	YES	Alerts operations of possible loss of environmental control in carbon bed rooms and/or carbon bed problems	20FMD016
FE/FIT-AWT-20-001	MEASURES FLOW TO AWWT	0 TO 50 GPM	N/A	5 and 25 GPM	N/A	Monitors flow to AWT	20FMD017
LE/LIT-TNK-20-002A	INDICATING WATER LEVEL IN HOLDUP TANK 002A	0 TO 10 FT	N/A	N/A	N/A	Cycles operating trains and initiates pump operation and/or termination	20FMD017
LE/LIT-TNK-20-002B	INDICATING WATER LEVEL IN HOLDUP TANK 002B	0 TO 10 FT	N/A	N/A	N/A	Cycles operating trains and initiates pump operation and/or termination	20FMD017
LE/LSH-SMP-20-001	DETECTS LIQUID IN SUMP	N/A	0.5 FT	2 FT.	YES	Alert operations and begin corrective action and cleanup	20FMD017
LSHH-TNK-20-002A	MONITORS HOLDUP TANK 002A LEVEL HIGH-HIGH	N/A	N/A	6.5 FT	YES	Alert operations and changes to different operating train	20FMD017
LSHH-TNK-20-002B	MONITORS HOLDUP TANK 002B LEVEL HIGH-HIGH	N/A	N/A	6.5 FT	YES	Alert operations and changes to different operating train	20FMD017
LSLL-TNK-20-002A	MONITORS HOLDUP TANK 002A LEVEL LOW-LOW	N/A	0.5 FT	N/A	YES	Terminates condensate transfer pump operations	20FMD017
LSLL-TNK-20-002B	MONITORS HOLDUP TANK 002B LEVEL LOW-LOW	N/A	0.5 FT	N/A	YES	Terminates condensate transfer pump operations	20FMD017
PDIT-TNK-20-002A	MONITORS PRESSURE IN TANK	-5 TO 5 "W.G.	-1.0" W.G.	0.1" W.G.	YES	Monitors pressure in condensate holdup tanks	20FMD017
PDIT-TNK-20-002B	MONITORS PRESSURE IN TANK	-5 TO 5 "W.G.	-1.0" W.G.	0.1" W.G.	YES	Monitors pressure in condensate holdup tanks	20FMD017
RE/RQIT-RCS-20-001	BUILDING ROOM MONITOR	0 TO 10,000 pCi/L	N/A	800 pCi/L	YES	Shutdown and assess ventilation supply and exhaust systems	20FMD017
GA-CHR-20-001A	MONITORS CHILLER PKG GENERAL ALARMS/INPUT	N/A	OUT OF PARAMETER CONDITIONS	OUT OF PARAMETER CONDITIONS	YES	Changeover of operating train	20FMD018

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PROCESS CONTROL KEY PAI. . .TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
GA-CHR-20-001B	MONITORS CHILLER PKG GENERAL ALARMS/INPUT	N/A	OUT OF PARAMETER CONDITIONS	OUT OF PARAMETER CONDITIONS	YES	Changeover of operating train	20FMD018
GA-DDS-20-001A	MONITORS DESICCANT DRYING PKG GENERAL ALARM/INPUT	N/A	OUT OF PARAMETER CONDITIONS	OUT OF PARAMETER CONDITIONS	YES	Changeover of operating train	20FMD018
GA-DDS-20-001B	MONITORS DESICCANT DRYING PKG GENERAL ALARM/INPUT	N/A	OUT OF PARAMETER CONDITIONS	OUT OF PARAMETER CONDITIONS	YES	Changeover of operating train	20FMD018
LSHH-DDS-20-001A	MONITORS CHILLER UNIT 001A WATER LEVEL HIGH-HIGH	0 TO 6 FT	N/A	2 FT.	YES	Alerts operation and changeover if required	20FMD018
LSHH-DDS-20-001B	MONITORS CHILLER UNIT 001B WATER LEVEL HIGH-HIGH	0 TO 6 FT	N/A	2 FT.	YES	Alerts operation and changeover if required	20FMD018
ME/MT-TOT-20-001	MONITORS TOTAL MOSITURE GOING INTO DESICCANT UNITS	0 TO 100% RH	N/A	N/A	NO	Feedback to PLC for capacity control of chiller units	20FMD018
PDIT-DDS-20-001A	MONITORS PRESSURE ACROSS DESICCANT DRYER UNIT	0 TO 10" W.G.	N/A	4" W.G.	YES	Changeover of operating train	20FMD018
PDIT-DDS-20-001B	MONITORS PRESSURE ACROSS DESICCANT DRYER UNIT	0 TO 10" W.G.	N/A	4" W.G.	YES	Changeover of operating train	20FMD018
PDIT-DDS-20-002	MONITORS PRESSURE TO CARBON BEDS	0 TO 20" W.G.	N/A	15" W.G.	YES	Alert operations of blockage and possible shutdown for protection of desiccant dryers	20FMD018
PDIT-FLT-20-001A	MONITORS PRESSURE ACROSS ROUGHING FILTER	0 TO 5" W.G.	0.5" W.G.	2.5" W.G.	YES	Alerts operations and operating train changeover if required filter replacement	20FMD018
PDIT-FLT-20-001B	MONITORS PRESSURE ACROSS ROUGHING FILTER	0 TO 5" W.G.	0.5" W.G.	2.5" W.G.	YES	Alerts operations and operating train changeover if required filter replacement	20FMD018
PDIT-SILO-20-003	MONITOR TOTAL DIFFERENTIAL PRESSURE FROM BOTH SILO 1 & 2	0 TO 20" W.G.	N/A	10" W.G.	YES	Alerts operations of static pressure and flow from both silos	20FMD018
FE/FIT-TOT-20-001	MONITORS AIR FLOW TO DRYING SYSTEM	0 TO 1000 ACFM	N/A	N/A	N/A	Feedback to PLC for capacity control of chiller units	20FMD018
TE/TT-TOT-20-001	MONITOR AIR TEMPERATURE INTO DESICCANT DRYING UNITS	0 TO 200 F	N/A	150F	YES	Feedback to PLC for capacity control of chiller units	20FMD018
FE/FIT-FAN-20-001A/B	MONITORS FLOW DISCHARGE FROM FAN-20-001A/B TO STACK	0 TO 1500 ACFM	N/A	N/A	N/A	Required for dose calculations System shutdown on double failure	20FMD019
FE/FIT-FAN-20-001R	MONITORS FLOW DISCHARGE FROM FAN-20-001A/B TO SUCTION SIDE (RECIRC.)	0 TO 1500 ACFM	N/A	N/A	N/A	Operational control	20FMD019
FE/FIT-FLT-20-004	MONITORS FLOW FRESH AIR INLET	0 TO 1000 ACFM	N/A	N/A	N/A	Operational control and measures the amount of makeup air added into system	20FMD019
IS-STK-20-001	STACK ISOKENITIC SAMPLER AND RADON MONITOR	Particulate - 0 - 10E-12 uCi/mL Radon: 0-20,000 pCi/L	Particulate - 1E-12 uCi/mL Radon: 2,000 pCi/L	Particulate - 5E-12 uCi/mL Radon: 6,000 pCi/L	YES	High measurements alerts operations to assess and correct RCS; At HH system shutdown	20FMD019
LE/LSH-STK-20-001	EXHAUST STACK SUMP LEVEL SWITCH HIGH	N/A	N/A	0.5 FT	YES	Alarms to alert operations personnel	20FMD019
LVR-20-015	CONTROLS INTAKE FLOW RATE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by fan discharge pressure	20FMD019
LVR-20-016	CONTROLS EXHAUST FLOW RATE TO STACK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by fan discharge pressure	20FMD019
LVR-20-020	CONTROLS RECIRC FLOW RATE	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by fan discharge pressure	20FMD019

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3157

PROCESS CONTROL KEY PAR... ...TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
PDIT-FAN-20-001A/B	MONITORS FAN-20-001A/B DISCHARGE PRESSURE	0 TO 15" W.G.	N/A	7" W.G.	YES	Controls stack exhaust and makeup air dampers located at fan; Adjustable over operations	20FMD019
PDIT-FLT-20-002A	MONITORS DIFFERENTIAL PRESSURE ACROSS FILTER TRAIN A	0 TO 10" W.G.	0.5" W.G.	1.5" W.G.	YES	Filter changeout	20FMD019
PDIT-FLT-20-002B	MONITORS DIFFERENTIAL PRESSURE ACROSS FILTER TRAIN B	0 TO 10" W.G.	0.5" W.G.	1.5" W.G.	YES	Filter changeout	20FMD019
PDIT-FLT-20-004	MONITORS DIFFERENTIAL PRESSURE ACROSS FILTER	0 TO 10" W.G.	0.5" W.G.	1.5" W.G.	YES	Filter changeout	20FMD019
RE/RQIT-RCS-20-002	MONITORS RADIATION IN THE RCS BUILDING	0 TO 10,000 pCi/L	N/A	800 pCi/L	YES	Shutdown and assess ventilation supply and exhaust systems	20FMD019
FQI-TOT-51-002	INDICATE TOTAL FLOW FROM POTABLE WATER SUPPLY	0 TO 50 gpm	N/A	N/A	N/A	Totalizes water used by system	51FMD002
PDI-FLT-77-002A	INDICATES DIFFERENTIAL PRESSURE ACROSS FILTER	0 TO 5" W.G.	2.0" W.G.	4.0" W.G.	YES	Filter changeout	77FMD006
PDI-FLT-77-002B	INDICATES DIFFERENTIAL PRESSURE ACROSS FILTER	0 TO 5" W.G.	2.0" W.G.	4.0" W.G.	YES	Filter changeout	77FMD006
PDIT-FLT-77-001	MONITORS DIFFERENTIAL PRESSURE ACROSS RCS BUILDING FRESH AIR FILTER	0 TO 5" W.G.	0.5" W.G.	2.0" W.G.	YES	Filter changeout	77FMD006
PDIT-RCS-77-001	MONITORS DIFFERENTIAL PRESSURE IN RCS BUILDING	-5 TO 5 "W.G.	N/A	0" W.G.	YES	Shutdown and assess ventilation supply and exhaust systems	77FMD006
PDIT-RCS-77-003	MONITORS DIFFERENTIAL PRESSURE IN CARBON BED 001A BUILDING	-5 TO 5 "W.G.	N/A	0" W.G.	YES	Adjust damper positions	77FMD006
PDIT-RCS-77-004	MONITORS DIFFERENTIAL PRESSURE IN CARBON BED 001B BUILDING	-5 TO 5 "W.G.	N/A	0" W.G.	YES	Adjust damper positions	77FMD006
PDIT-RCS-77-005	MONITORS DIFFERENTIAL PRESSURE IN CARBON BED 002A BUILDING	-5 TO 5 "W.G.	N/A	0" W.G.	YES	Adjust damper positions	77FMD006
PDIT-RCS-77-006	MONITORS DIFFERENTIAL PRESSURE IN CARBON BED 002B BUILDING	-5 TO 5 "W.G.	N/A	0" W.G.	YES	Adjust damper positions	77FMD006
FE/FIT-FAN-77-001A/B	MONITORS FLOW DISCHARGE FROM FAN-77-001A OR B	0 TO 15,000 ACFM	N/A	N/A	N/A	Required for dose calculations	77FMD008
PDIT-FLT-77-002A	MONITORS DIFFERENTIAL PRESSURE ACROSS RCS BUILDING A FILTER	0 TO 10" W.G.	2.0" W.G.	4.0" W.G.	YES	Alerts operations to filter changeout	77FMD008
PDIT-FLT-77-002B	MONITORS DIFFERENTIAL PRESSURE ACROSS RCS BUILDING B FILTER	0 TO 10" W.G.	2.0" W.G.	4.0" W.G.	YES	Alerts operations to filter changeout	77FMD008
RE/RQIT-RCS-77-001	MONITORS RADIATION IN THE RCS BUILDING	0 TO 10,000 pCi/L	N/A	800 pCi/L	YES	Shutdown and assess ventilation supply and exhaust systems	77FMD008
PDIT-SILO-10-001	MONITORS PRESSURE IN SILO 4	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	NO	Mockup System	10FMD004
FE/FIT-FLT-10-001	MONITORS FRESH AIR FLO INLET FOR SILO 4	0 TO 1500 ACFM	N/A	N/A	NO	Mockup System	10FMD005

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3152

PROCESS CONTROL KEY PA[illegible]TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
FE/FIT-SILO-10-001	MONITORS SUPPLY AIR FLOW TO SILO 4	0 TO 1500 ACFM	N/A	N/A	NO	Mockup System	10FMD005
FE/FIT-SILO-10-002	MONITORS RETURN AIR FLOW FROM SILO 4	0 TO 1500 ACFM	N/A	N/A	NO	Mockup System	10FMD005
LVR-10-003	CONTROL FRESH AIR INLET	0 TO 100%	N/A	N/A	NO	Mockup System	10FMD005
LVR-10-004	CONTROL EXHAUST TO STACK	0 TO 100%	N/A	N/A	NO	Mockup System	10FMD005
LVR-10-005	CONTROL RECIRCULATION AIR	0 TO 100%	N/A	N/A	NO	Mockup System	10FMD005
PIT-PMP-11-301P	MONITOR DISCHARGE PRESSURE	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD011
PIT-PMP-11-301S	MONITOR DISCHARGE PRESSURE	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD011
PIT-SP-001	MONITORS PRESSURE IN TRANSFER LINE	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
PIT-SP-002	MONITORS PRESSURE IN TRANSFER LINE	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
PIT-SP-003	MONITORS PRESSURE IN TRANSFER LINE	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
PIT-SS-001	PRIMARY SLURRY LINE PRESSURE INDICATION	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
PIT-SS-002	SPARE SLURRY LINE PRESSURE INDICATION	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
PIT-SS-003	PRIMARY SLURRY LINE PRESSURE INDICATION	0 TO 500 psig	N/A	250 psig	YES	Alerts operations of out of potential problems	11FMD012
AE/AT-PMP-12-200/201	MONITORS DENSITY/FLOW IN SLUICE WATER	300 GPM / 1.2 SG	N/A	1.2 S.G.	YES	Alerts operations of out of parameter sluice water concentrations	11FMD014
LT/LC-TNK-12-001A	MONITORS WATER LEVEL & SLUDGE LEVEL IN TTA TANK 1A	0 TO 40 FT	1 FT (DELTA)	26.5 FT	YES	Termination of decant pump operations	12FMD010
LT/LC-TNK-12-001B	MONITORS WATER LEVEL & SLUDGE LEVEL IN TTA TANK 1B OR 2B	0 TO 40 FT	1 FT (DELTA)	26.5 FT	YES	Termination of decant pump operations	12FMD011
LT/LC-TNK-12-002A	MONITORS WATER LEVEL & SLUDGE LEVEL IN TTA TANK 1A OR 2A	0 TO 40 FT	1 FT (DELTA)	26.5 FT	YES	Termination of decant pump operations	12FMD012
LT/LC-TNK-12-002B	MONITORS WATER LEVEL & SLUDGE LEVEL IN TTA TANK 1B OR 2B	0 TO 40 FT	1 FT (DELTA)	26.5 FT	YES	Termination of decant pump operations	12FMD013
RQIT-TTA-20-001	TTA AREA RADIATION MONITOR	0 TO 10,000 pCi/L	N/A	800 pCi/L	YES	Shutdown and assess ventilation supply and exhaust systems	20FMD014
FE/FIT-FLT-20-005	MONITORS INTAKE AIR FLOW TO TTA	0 TO 1000 ACFM	N/A	N/A	N/A	Measurement of flow to TTA tank	20FMD015
FE/FIT-TNK-12-001A	MONITOR TANK FLOW	0 TO 1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from TTA tank	20FMD015
FE/FIT-TNK-12-001B	MONITOR TANK FLOW	0 TO 1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from TTA tank	20FMD015
FE/FIT-TNK-12-002A	MONITOR TANK FLOW	0 TO 1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from TTA tank	20FMD015
FE/FIT-TNK-12-002B	MONITOR TANK FLOW	0 TO 1000 ACFM	N/A	500 ACFM	YES	Measurement of flow from TTA tank	20FMD015
LVR-20-007	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-008	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015

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PROCESS CONTROL KEY PAI. _TERS/SETPOINT TABLE

TAG NO.	FUNCTION	INSTRUMENT RANGE	L-SP	H-SP	ALARMS	RESPONSE	P & ID
LVR-20-009	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-010	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-011	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-012	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-013	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
LVR-20-014	CONTROL PRESSURE IN TANK	0 TO 100%	N/A	N/A	N/A	Opposed blade damper actuated by silo pressure	20FMD015
PDIT-FLT-20-005	MONITORS DIFFERENTIAL PRESSURE ACROSS TTA TANK FRESH AIR FILTER	0 TO 5" W.G.	1.0" W.G.	2.0" W.G.	YES	Sweep air across TTA tanks	20FMD015
PDIT-TNK-12-001A	MONITOR AND CONTROL TANK PRESSURE	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint	20FMD015
PDIT-TNK-12-001B	MONITOR AND CONTROL TANK PRESSURE	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint	20FMD015
PDIT-TNK-12-002A	MONITOR AND CONTROL TANK PRESSURE	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint	20FMD015
PDIT-TNK-12-002B	MONITOR AND CONTROL TANK PRESSURE	-5 TO 5 "W.G.	-2.0" W.G.	0.5" W.G.	YES	Damper modulation to regain operating setpoint	20FMD015

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FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SAMPLING PLAN

DOCUMENT NO.
624-P621-13, Rev. C

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

SUBMITTED TO:

FLUOR FERNALD, INC.

CONTRACT NO. FSC 624

June 1, 2000

3157

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SAMPLING PLAN
Revision C

Recommended by:

Foster Wheeler Engineering Manager **Date**

Approved by:

Foster Wheeler Project Manager **Date**

TABLE OF CONTENTS

3157

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Scope and Purpose of Plan 2
1.3 Organization of Plan 2
2.0 DATA QUALITY OBJECTIVES AND QUALITY CONTROL 3
2.1 DQOs and Intended Use of Acquired Data 3
2.1.1 Wastewater 3
2.1.2 Air Emissions 3
2.1.3 Silo Residues 4
2.2 Elements of Quality Control (QC) 4
2.2.1 Laboratory Control Sample (LCS) 4
2.2.2 Internal Standards (IS) 5
2.2.3 Method Blank 5
2.2.4 Field Duplicate 5
2.2.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) 5
2.2.6 Analytical Methods 5
2.3 Supplies and Consumables 6
3.0 SAMPLING MEDIA AND SOURCES 7
3.1 Wastewater 7
3.1.1 RCS Condensate Tanks 7
3.1.2 Filtrate Storage Tank 7
3.2 Air Emissions 7
3.2.1 RCS Stack 8
3.2.2 Process Monitoring of Radon Concentrations 8
3.3 Silo Residues 9
4.0 SAMPLING AND ANALYTICAL METHODS 10
4.1 Wastewater 10
4.1.1 Sample Collection and Screening Methods 10
4.1.2 CSL Radiological Analytical Methods 12
4.1.3 Remaining CSL Analytical Methods 12
4.2 Air Emissions 13
4.2.1 Stack Monitoring 13
4.2.2 Radon Process Monitoring 15
4.3 Silo Residues 16
5.0 DOCUMENTATION AND RECORDKEEPING 17
5.1 Field Logbook 17
5.2 Sample Container Labeling 17
5.3 Sample Packaging and Shipping 17
5.4 Chain-of-Custody (COC) 18
5.5 Records Storage 18
5.6 Analytical Data 19
5.6.1 Wastewater Samples 19
5.6.2 Air Emissions Samples 19
6.0 WASTE MANAGEMENT PLAN 20
6.1 Wastewater 20
6.2 Consumables 20
7.0 REFERENCES 21

APPENDICES

APPENDIX A	Advanced Wastewater Treatment (AWWT) Facility Waste Acceptance Criteria (WAC) for the Accelerated Waste Retrieval (AWR) Project
APPENDIX B	Summary of Analytical Procedures, Containers, Preservatives, and Holding Time Requirements for Wastewater Samples
APPENDIX C	Wastewater Sample Collection Guideline
APPENDIX D	Typical Analytical Methods for Air Emissions Analyses
APPENDIX E	Air Emissions Monitoring – Radon Control System (RCS) Stack Sampling Guideline
APPENDIX F	Manual Chain-of-Custody (COC) Guideline

3157

ACRONYM LIST

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ASL	analytical support level
AWR	Accelerated Waste Retrieval
AWWT	Advanced Wastewater Treatment
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	chain-of-custody
CSL	Contract Services Laboratory
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	Data Quality Objective
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
ES&H	environmental safety and health
FAT&LC	Fernald Atomic Trades and Labor Council
FEMP	Fernald Environmental Management Project
Fluor Fernald	Fluor Fernald, Inc.
FWENC	Foster Wheeler Environmental Corporation
gpd	gallons per day
gpm	gallons per minute
HASL	Health and Safety Laboratory
HASP	Health and Safety Plan
kg/day	kilograms per day
lb/day	pounds per day
LCS	Laboratory Control Sample
MeV	million electronvolts
MSCC	Material Segregation and Containerization Criteria
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code
pCi/L	picocuries per liter
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
PWID	Project Waste Identification and Disposition
QA	quality assurance
QA/QC	quality assurance/quality control
QC	quality control
RCS	Radon Control System
SOP	Standard Operating Procedure
TEDE	total effective dose equivalent
TRD	Technical Requirements Document
TSS	total suspended solids
TTA	Transfer Tank Area
WAC	waste acceptance criteria
WL	working levels

1.0 INTRODUCTION

3157

This Sampling Plan addresses the requirements for the collection and analysis of wastewater and air emission samples associated with the Accelerated Waste Retrieval (AWR) Project at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site near Cincinnati, Ohio. This Plan has been developed and shall be executed in accordance with the *Sitewide Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Quality Assurance Project Plan* (FD-1000) prepared by Fluor Fernald, Inc. (Fluor Fernald).

1.1 Background

The source of contamination for the AWR Project is the radioactive waste stored in Silos 1 and 2. The AWR Project will involve the safe and effective removal of radioactive decay gases, K-65 residues and bentonite, and other debris contained in Silos 1 and 2 and the Decant Sump Tank. Accumulated concentration of radon gas in the silo headspaces is reduced through the operation of the Radon Control System (RCS). This system will operate on a 24-hour basis and will generate a condensate requiring discharge to the FEMP's Advanced Wastewater Treatment (AWWT) facility.

The bulk of the solid waste is transferred with the addition of water through a sluicing device and pumped as slurry through the transfer line to the shielded Transfer Tank Area (TTA). This process may generate wastewater in the form of filtrate during the latter stages of the AWR Project when the TTA storage capacity is expected to be limited. Wastewater (i.e., condensate and filtrate) and air emissions from the RCS stack produced during the AWR Project require the generation of characterization data in accordance with the data quality objectives (DQOs) described in Document No. 624-P621-12, *Data Quality Objectives*, and therefore, require sampling and analysis in accordance with this Sampling Plan. (Note: Wastewater from the Decant Sump Tank will be transferred to the TTA and managed from that point similar to the filtrate. Therefore, water to be sent to the AWWT facility will come from either the RCS condensate tanks or the TTA filtrate tanks).

1.2 Scope and Purpose of Plan

The purpose of this Sampling Plan is to describe the sampling and analysis efforts associated with the DQOs for the AWR Project. These efforts are generally twofold in scope, as summarized below:

- Ensure that the periodic discharge of excess water from the AWR Project meets waste acceptance criteria (WAC) prior to being transferred to the FEMP's AWWT facility; and
- Ensure that the air emissions associated with the AWR Project meet the applicable regulatory and FEMP site standards.

An additional sample collection effort is required for the AWR Project that relates to obtaining archive samples of silo residues for future use. Since DQOs and related analytical requirements are to be determined by Fluor Fernald, only an overview of the sampling methodology proposed for the silo residues is provided in this Sampling Plan.

1.3 Organization of Plan

This Sampling Plan has been prepared to address the requirements of the AWR Contract, specifically paragraph 3.1.13 of the *Technical Requirements Document* (TRD), Fluor Fernald No. 40710-RP-0001, February 3, 1999, Revision 1. This Sampling Plan and its implementation will comply with the *FEMP Sitewide CERCLA Quality Assurance Project Plan* (FD-1000) and applicable local, state, and federal regulatory requirements.

Section 1 of this Sampling Plan provides an introduction including AWR Project background and the purpose and scope of this Plan. Section 2 describes the DQOs and quality control (QC) associated with the sampling and analysis activities for the AWR Project. Section 3 describes the sampling media and sources, while Section 4 provides an overview of the field sampling procedures. Section 5 discusses the appropriate documentation and recordkeeping related to sampling for the AWR Project, including chain-of-custody (COC) and records management. Section 6 provides an overview of the waste management requirements associated with sampling activities for the AWR Project, and finally, Section 7 lists the references used in the preparation of this Plan. In addition to the text of this Sampling Plan, supporting technical information is provided in several appendices to this Plan, as listed below:

- Appendix A — AWWT WAC for the AWR Project;
- Appendix B — Summary of Analytical Procedures, Containers, Preservatives, and Holding Time Requirements for Wastewater Samples;
- Appendix C — Wastewater Sample Collection Guideline;
- Appendix D — Typical and Alternative Analytical Methods for Air Emissions Analyses;
- Appendix E — Air Emissions Monitoring – RCS Stack Sampling Guideline; and
- Appendix F — Manual COC Guideline.

The guidelines presented in the appendices relating to sample collection methods will be used in the development of detailed AWR Project procedures. Detailed sampling procedures will be prepared as part of the operational procedures associated with the RCS and the TTA. Specifically, the sampling/monitoring associated with the condensate tanks, carbon beds, and stack will be addressed in the *RCS Phase 1 and 2 Standard Operating Procedures (SOPs)*, which are AWR Project Submittals 624-P633-01 and 624-P636-01. The sampling of the filtrate storage tank will be addressed in the *AWR SOPs* (Submittal No. 624-P6315-01). This approach was approved by Fluor Fernald in response to Foster Wheeler's "Request for Technical Clarification or Information" (RTCI) No. 043. The samples described in this Sampling Plan are to be collected by Fernald Atomic Trades & Labor Council (FAT&LC) personnel.

With regards to analytical methods and performance, a Contract Services Laboratory (CSL) will be subcontracted by Foster Wheeler to complete the laboratory analyses for air emissions and wastewater samples identified in this Sampling Plan in accordance with approved procedures. The CSL will be evaluated prior to subcontract award regarding its ability to meet the quality assurance/quality control (QA/QC) requirements of this Plan and to perform work in accordance with the analytical methods prescribed herein.

2.0 DATA QUALITY OBJECTIVES AND QUALITY CONTROL 3157

Decisions will be made as a result of the AWR Project sample collection and analysis efforts. Members of the decision process related to these efforts include appropriate AWR Project personnel from both Fluor Fernald and Foster Wheeler. These members include the Project Manager (PM), Operations/Maintenance/Systems Closure Manager, environmental safety and health (ES&H) professionals, and quality specialists. This section provides an overview of the DQOs and QC elements associated with the AWR Project sampling and analysis efforts that implement this decision process.

2.1 DQOs and Intended Use of Acquired Data

As defined by the U.S. Environmental Protection Agency (EPA), DQOs are qualitative and quantitative statements developed to specify the quality of data from field and laboratory data collection activities needed to support specific decisions. The DQOs describe the level of data needed, why the data is needed, and how the data will be used to support process operations. DQOs also ensure that the data collected is of sufficient quality and quantity for the data user's application. The DQOs for the AWR Project are outlined in Document No. 624-P621-12, *Data Quality Objectives.*

2.1.1 Wastewater

Analytical data will be utilized to determine if the wastewater meets the AWWT WAC prior to its transfer. If the AWWT WAC is met, then process wastewater from the AWR Project is transferred to the FEMP AWWT facility for final treatment and discharge in accordance with the FEMP National Pollutant Discharge Elimination System (NPDES) permit. Wastewater found to exceed the AWWT WAC limits will be returned to the waste retrieval system for use in the sluicing process or treated to meet the WAC, as appropriate, prior to its transfer to the FEMP AWWT facility.

The AWWT can accept a total of 7,200 gallons per day (gpd) at the rate of 5 gallons per minute (gpm) from the AWR Project. The WAC for the AWWT facility is provided in Appendix A of this Sampling Plan. In addition, several other water quality parameters (i.e., chloride, nitrate, carbonate, and sulfate) are to be monitored and reported to Fluor Fernald in accordance with the TRD for the AWR Project.

2.1.2 Air Emissions

Air emissions associated with the AWR Project must meet applicable DOE and EPA environmental regulations and AWR Contract requirements. In the initial phase of the AWR Project, the accumulated radon gas in the silo headspaces is purged through the RCS. In addition, the RCS continually operates throughout the waste transfer and storage process of the AWR Project. Air emissions from the RCS stack will be monitored to ensure the appropriate air emission standards are being met.

The continuous air monitoring systems, as later described in Sections 3 and 4 of this Sampling Plan, are used to assess RCS operations and process control, as well as to signal the need for corrective actions to prevent onsite or public exposures from air emissions exceeding established limits. These monitoring systems will have alarms that are preset to provide timely warnings to AWR Project operations staff. For example, if the radon concentrations do not exceed the preset alarm levels for the monitors located upstream of each carbon bed, then the

relevant AWR Contract and regulatory requirements rare being met. In addition, the ratio between the concentrations measured by the upstream and downstream monitors is maintained at or above the design value. If the preset alarm levels are exceeded, then alarms will sound and indications will be shown on the control panel located in the AWR Project control trailer. Mitigation measures and corrective actions will be implemented accordingly. In the same sense, if the radon concentrations do not exceed the preset alarm level for the stack monitors, then the RCS is functioning within limits and no mitigative actions are required. If the preset stack alarm levels are exceeded, then alarms will sound and indications will be shown on the control panel located in the AWR Project control trailer, with corresponding mitigation measures and corrective actions implemented accordingly.

2.1.3 Silo Residues

After the waste transfer process, samples of the silo residues will be taken from the TTA tanks and stored onsite for future use as determined by Fluor Fernald. There are no definitive DQOs or analytical requirements currently associated with the silo residues, and therefore, the proposed sampling methodology is only summarized in this Sampling Plan (see Section 4.3).

2.2 Elements of Quality Control (QC)

This section presents QC requirements relevant to the analysis of wastewater and air emissions samples that shall be followed by the CSL during analytical activities producing definitive data (i.e., data not measured using onsite instruments) for the AWR Project. The purpose of these requirements is to produce data of known quality that satisfies the AWR Project goals and that meets or exceeds the requirements of the standard methods of analysis. These requirements provide a mechanism for ongoing control and evaluation of data quality measurements.

CSL QC samples (i.e., blanks and laboratory control samples) will be included in the preparation batch with the field samples. The preparation batch is a number of samples (not to exceed 20) that are similar in composition and that are extracted or digested at the same time and with the same lot of reagents. The identity of each preparation batch will be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated wastewater or air emission sample. The type of QC samples used for spiking will include the analytes of interest. Additional QC samples may be added to those required by the method to ensure accurate and precise data.

2.2.1 Laboratory Control Sample (LCS)

A LCS is an aliquot of a contaminant-free matrix fortified (spiked) with a known concentration of compound. Samples shall have a LCS spiked with appropriate analytes of interest. The CSL shall prepare and analyze a LCS with each batch of samples. The LCS is subjected to the entire analytical procedure in order to evaluate method performance. Present recovery determinations from these control samples shall be monitored to provide a continuous measure of each method's accuracy.

When an analyte in a LCS is outside the acceptable recovery limit, corrective action must be performed. After the system problems have been resolved and system control has been reestablished, samples in the analytical batch will be reanalyzed for the out-of-control method. When an analyte in a LCS exceeds the upper or lower control limits and no corrective action is performed, an appropriate validation flag shall be applied to affected results.

3157

2.2.2 Internal Standards (IS)

IS are measured amounts of certain compounds added prior to analysis of samples. These standards are used in an IS calibration method to correct sample results by columns injection losses or viscosity effects. When the IS results are outside the acceptance limits, corrective action must be performed. If corrective actions are not performed, then an appropriate validation flag shall be applied to the sample results.

2.2.3 Method Blank

A method blank is defined as a CSL-demonstrated analyte-free matrix that is carried through the entire analytical procedure. A method blank is prepared and analyzed for each batch of samples for applicable parameters. The method blank is used to determine the level of CSL background contamination. Unfavorable method blank performance renders associated data suspect and requires corrective action and/or data qualification.

The presence of analytes in a method blank at concentrations greater than the practical quantification limit indicates a need for corrective action. Corrective actions shall be performed to eliminate the source of contamination prior to proceeding with analyses. No analytical data will be corrected for the presence of analytes in blanks. When an analyte is detected in the blank and in the associated samples and corrective actions are not necessary, an appropriate validation flag shall be applied to the sample results.

2.2.4 Field Duplicate

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate sample results are used to assess precision, including variability associated with both the CSL analysis and the sample collection process. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis.

Field duplicates shall be collected and analyzed for 10 percent of the samples. The sample containers will be assigned a control number such that they cannot be identified (blind duplicate) as duplicate samples by CSL personnel performing the analysis.

2.2.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

An aliquot of a matrix (e.g., water) is fortified, or spiked, with a known concentration of target compounds. The spike solution will consist of the same compounds used for the LCS. The MS/MSD are subjected to the entire analytical procedure in order to indicate both accuracy and precision of the method for the matrix by measuring the percent recovery and the relative percent difference of the two spiked samples. These samples are also used to assess matrix interference effects on the method, as well as to evaluate instrument performance. MS/MSD shall be analyzed for each analytical batch in order to maintain continuous surveillance of acceptable method performance.

2.2.6 Analytical Methods

Analysis of the wastewater and air emissions samples shall comply with methods approved or recognized by the EPA and/or other regulatory agencies. The analytical methods for waste-

water and air emissions samples are identified in Appendices B and D, respectively, of this Sampling Plan. No specific analysis is identified for the archived K-65 silo residues at this time.

2.3 Supplies and Consumables

The CSL used for conducting wastewater and air emissions samples shall provide and inspect supplies and consumables prior to use in analyses. The materials description in the methods of analysis will be used as a guideline for establishing the acceptance criteria for these materials. Introduction of interfering compounds into the analytical process shall be monitored by analysis of methods blanks. The inventory and storage system for these materials will assure use before manufacturer's expiration dates and storage under safe and chemically compatible conditions. For the handling of consumables used in the actual collection of samples in the field, see Section 6 of this Sampling Plan.

3.0 SAMPLING MEDIA AND SOURCES

3157

Both wastewater and air emissions samples will be collected and analyzed as part of the AWR Project. In addition, process monitoring of radon concentrations will be performed and samples of silo residues will be collected for future use. This section describes these samples and their respective sources. Section 4 and related appendices of this Sampling Plan provide details regarding the respective guidelines used for sample collection and methods of analysis for only wastewater and air emissions for the AWR Project.

3.1 Wastewater

Water will be used to hydraulically transport silo residues from the existing silos into the TTA. During this transfer process, water may be added to the sluicing operations or periodically removed. Wastewater withdrawn from the sluicing process (via one 7,500-gallon filtrate storage tank) and the RCS (via two 3,000-gallon condensate tanks) will be eventually transferred to the FEMP AWWT facility.

Foster Wheeler has identified two wastewater streams requiring segregation and transfer to the FEMP AWWT facility, and therefore, requiring characterization. The first wastewater stream is the accumulation of condensate during the operation of the RCS. This condensate is collected in two 3,000-gallon tanks in the RCS Building. The second wastewater stream is a portion of the water used during the slurry transfer activities. Although the wastewater from the sluicing operation is recycled to reduce water usage, a portion of this wastewater (including water from the Decant Sump Tank) is processed through a filtration system located on the TTA deck. Wastewater may be removed as filtrate for transfer to the FEMP AWWT facility during the latter stages of the AWR Project when the overall TTA storage capacity is limited. This filtrate is collected in a 7,500-gallon tank located on the TTA deck.

3.1.1 RCS Condensate Tanks

As a function of the RCS operations, condensate will accumulate and be collected in two 3,000-gallon condensate tanks in the RCS Building prior to final transfer to the FEMP AWWT facility. The sampling guideline for wastewater (i.e., condensate) emanating from these tanks is summarized in Section 4 of this Sampling Plan and provided in Appendix C to this Plan.

3.1.2 Filtrate Storage Tank

Although the water used in the sluicing operations is enclosed in a closed loop network, periodically excess wastewater (in the latter stages of the AWR Project) will be processed through a filtration system and collected in a 7,500-gallon filtrate storage tank on the TTA deck prior to final transfer to the FEMP AWWT facility. The sampling guideline for wastewater (i.e., filtrate) emanating from this tank is summarized in Section 4 of this Sampling Plan and provided in Appendix C to this Plan.

3.2 Air Emissions

In the initial phase of the AWR Project, the accumulated radon gas in the silo headspaces is purged through the RCS. In addition, the RCS continually operates throughout the waste transfer process, and continues operation for the TTA throughout the waste storage phase of the AWR Project.

3.2.1 RCS Stack

Monitoring the radon concentrations in the RCS stack is required to demonstrate compliance with the AWR Contract requirements for onsite and offsite concentrations. Monitoring the particulate emissions in the RCS stack using an isokinetic sampler (supplemented by CSL analyses of filter paper composites) is required to demonstrate compliance with the dose limit in Title 40 of the Code of Federal Regulations (CFR) Part 61, Subpart H. Emissions from the RCS stack will also monitored for compliance with other applicable emissions standards. The monitors used for this sampling (both radon and particulate emissions) are described in Section 4 of this Sampling Plan. Specifically, operation of the stack monitor is described in Section 4.2.1 of this Plan. The sampling guideline for airborne particulate emissions (i.e., RCS stack sampling) is provided in Appendix E to this Plan.

As stated, monitoring of particulate emissions will be conducted using an isokinetic sampler in the RCS stack. The filter from the continuous monitor will be changed every two weeks, or monthly if it can be shown that there is no significant buildup of particulates. Also, the monitor will be inspected when the filter is changed. These filter papers will then be analyzed either onsite or by the CSL using the methods identified in Appendix D of this Plan to confirm data from the monitor, as well as to document compliance with 40 CFR 61. In addition, semi-annual composites of these filters will be analyzed by the CSL, with resulting data used in the calculation of the total effective dose equivalent (TEDE). This value is combined with the dose values from other Fluor Fernald activities at the FEMP site to demonstrate compliance with 40 CFR 61 and DOE Order 5400.5. The semi-annual composites will also be analyzed for lead to demonstrate compliance with Ohio Administrative Code (OAC) 3745-31-05(A)(3), *"Permit to Install New Sources of Pollution"*.

3.2.2 Process Monitoring of Radon Concentrations

Carbon bed performance is instrumental in reducing the concentrations of radon in the silo and TTA headspaces and in managing the emissions of radon to the environment. It is important to have a measurement that provides for an assessment of carbon bed performance so trends can be promptly identified, and steps taken to enhance performance if necessary. In addition, it is necessary to meet the AWR Contract requirement requiring that the dose rate from radon in the silo headspaces is reduced to below 10 mrem/hr during construction periods of Phase 1 and during Phase 2 of the AWR Project.

A representative air stream will be diverted through an in-line monitor at one of two locations to measure radon concentrations upstream of the four carbon bed systems. One measurement point is upstream of the junction where TTA, process, and RCS ducts join. This point is used to assess the performance of the RCS in the reduction of radon concentrations in the headspaces. The measurement at the second location (downstream of that junction) serves as a "before" measurement for comparing "before" and "after" concentrations to assess the performance of each carbon bed. A representative air stream must also be diverted through an in-line monitor to measure radon concentrations downstream of each carbon bed to assess bed performance for process control purposes. These four measurements serve as the "after" concentrations for comparing "before" and "after" concentrations to assess the performance of each carbon bed.

3.3 Silo Residues

3157

Technical requirements TTA-021 through TTA-026 of AWR Project TRD (Document No. 40710-RP-0001) provide requirements for extracting samples of K-65 material and BentoGrout™ (i.e., silo residues) that have been removed from Silos 1 and 2 and stored in the TTA Transfer Storage Tanks. Samples will be taken at a quantity of 15 gallons per 10% of silo residues transferred, or 150 gallons total. After the samples have been withdrawn from the storage tanks, the samples are to be free of liquids, packaged in 55-gallon drums, stored in a shielded, accessible area, and labeled in accordance with applicable AWR Contract requirements. An overview of the sampling methodology is provided in Section 4.3.

4.0 SAMPLING AND ANALYTICAL METHODS

Representative samples must be collected to appropriately characterize process wastewater and air emissions from the AWR Project in accordance with this Sampling Plan. Collection, handling, and shipment of samples will be performed according to AWR Project procedures, as low as reasonably achievable (ALARA) practices, and applicable U.S. Department of Transportation (DOT) shipping guidelines.

4.1 Wastewater

CSL analytical methods will be used in determining whether or not the AWWT WAC is met, however, screening is first performed to determine the likelihood of wastewater samples in meeting the radionuclide WAC parameters, and if so determined, will be sent to the CSL for more definitive analysis. The CSL will then perform a two-step confirmation process. The CSL will first determine if the radionuclide WAC parameters are met, and if so met, then will determine whether the WAC metals and general chemistry parameters are met. A summary of analytical procedures, containers, preservatives, and holding time requirements for wastewater samples is provided in Appendix B of this Sampling Plan.

Representative samples are needed from each batch of RCS condensate wastewater and filtrate wastewater in sufficient time prior to planned discharge. This timeframe must allow for field screening, sample packaging and shipment to the CSL for analysis, data receipt and reporting, etc., as required, to determine that the AWWT WAC requirements are met. The transfer of wastewater to the FEMP AWWT cannot occur until the WAC is met and Fluor Fernald approval is obtained.

The design of the AWR Project, more specifically the RCS condensate tanks and the TTA filtrate storage tank, includes ports or outlets for the collection of wastewater samples. These ports will be the source of wastewater collected for sampling under this Sampling Plan. Each tank is considered a batch release and will be circulated, as required, to ensure a representative sample of tank contents. Circulation of the condensate tanks is not required since the condensate is free of solids and homogeneous in nature. Contents of the filtrate tank may not be homogeneous in nature, and therefore, will be circulated to achieve the mixing of one tank volume prior to sampling.

To ensure a representative wastewater sample is collected from the RCS condensate tanks, one sampling line volume will be purged prior to collection of the sample. This one line volume will include water held in the piping from the individual tank to the sampling port. To ensure a representative wastewater sample is collected from the filtrate tank, one tank volume (i.e., 7,500 gallons) will be recirculated prior to sampling and one sampling line volume will be purged prior to collection of the sample. Appendix C of this Sampling Plan provides a guideline for collecting these wastewater samples for the AWR Project.

4.1.1 Sample Collection and Screening

For screening of AWR Project wastewater samples, the samples need to be properly collected (as summarized above and described in the Appendix C guideline) and then analyzed to determine the overall concentrations of radionuclides. Samples of wastewater (approximately 1 liter or less) will be collected in plastic (or glass) bottles from sampling ports on the RCS condensate tanks and the TTA filtrate storage tank. The outside of the bottles will be cleaned

and bagged to prevent cross-contamination and then sent to either the onsite FEMP laboratory or the CSL for gross alpha and beta analyses. Samples from the bottles will be dried and analyzed using a proportional counter. Procedures A-01-R and B-01-R of DOE's Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, will be used for this screening analysis. These analyses should provide an adequate screening evaluation to determine whether the water is likely to be less than or greater than the WAC discharge limits.

Table 4-1 lists the radiological limits from the WAC and the predominant radionuclides in the waste. This information was used to determine preliminary screening analysis limits. When both factors were considered, the most limiting alpha emitter was determined to be Ra-226 and the preliminary gross alpha screening limit was determined to be approximately 185 pCi/L. Water containing higher concentrations of gross alpha activity would not be expected to meet the WAC. Similarly, the most limiting beta emitter was found to be Pb-210 and the preliminary gross beta screening limit should be approximately 60 pCi/L. This limit accounts for the fact that Pb-210 and its daughter bismuth (Bi)-210 occur with approximately equal beta activities, but only Pb-210 is listed in the WAC.

Table 4-1. WAC Discharge Limits and Sample Screening Considerations

Radionuclide (and Emission Type)	Discharge Limit, pCi/L	Relative Activity (pCi/L)[1,2]	
		Silo 1	Silo 2
Ac-227 (β)	10	2	3
Pb-210 (β)	30	42	72
Po-210 (α)	80	59	88
Pa-231 (α)	10	—	2
Ra-226 (α)	100	100	100
Ra-228 (α)	100	—	—
Th-228 (α)	400	<1	3
Th-230 (α)	300	14	29
Th-232 (α)	50	<1	<1
U-234 (α)	500 (or 5 ppm)	<1	<1
U-235/236 (α)	600 (or 5 ppm)	<1	<1
U-238 (α)	600 (or 5 ppm))	<1	<1

Notes: [1] Source: Hazard Analysis Report for Operable Unit 4 (OU4) Silos, Appendix C, Table 4-4.
[2] Compared to 100 pCi of Ra-226.

By meeting these concentrations, samples have a high probability of meeting the WAC, and therefore, further analyses by the CSL (e.g., high-resolution spectroscopy, RCRA metals, and general chemistry analysis) are justified. If after analysis by the CSL the discharge limits are not met, then the water will not be transferred to the AWWT facility.

Note that the screening limits may be raised or lowered to balance unnecessary analytical costs versus the costs of unnecessary treatment and resampling of the water.

4.1.2 CSL Radiological Analytical Methods

Samples that pass the screening evaluations are sent to the CSL for a more definitive determination using high-resolution gamma spectra analysis with a large, sensitive germanium detector system. This system will utilize a multi-channel analyzer and sophisticated software to identify the energy of specific gamma peaks and quantify the concentrations of radionuclides (e.g., Pa-231, Ra-226, Th-228, Th-230, Th-232, U-234, and U-235). This system will be calibrated in accordance with applicable standards and will have sufficient sensitivity and accuracy to measure the concentration of the radionuclides in the wastewater samples to levels approximately one-half of the specified AWWT WAC discharge limits.

Both typical and alternative analytical methods, or approved equivalents, to be used by the CSL are presented in Tables 4-2 and 4-3. The monitoring and reporting of results obtained from the testing of these parameters will satisfy the AWR Contract requirements for radiological characterization data associated with AWR Project wastewater.

Table 4-2. Typical Analytical Methods for Wastewater Analyses

Parameter	Analytical Method[1]
Radionuclide	
Ac – 227	G-01 and A-01-R
Pb – 210	Pb-01-RC
Po – 210	Po-01-RC
Pa – 231	G-01 and A-01-R
Ra – 226	Ra-06-RC
Ra – 228	Th-01-RC
Th – 228	Th-01-RC
Th – 230	
Th – 232	
U – 234	U-02-RC
U – 235/236	
U – 238	

Notes: [1] EML procedure specifies test methods and detection limits, as provided in the HASL-300.

Table 4-3. Alternative Analytical Methods for Wastewater Analyses

Parameter	Analytical Method[1]
Radionuclide	
Gross alpha	A-01-R
Gross beta	B-01-R
Gamma isotopic	Ga-01-R

Notes: [1] EML procedure specifies test methods and detection limits, as provided in HASL-300.

4.1.3 Remaining CSL Analytical Methods

Upon confirmation that the CSL analytical data indicates the respective samples meet the AWWT WAC for radionuclides, the CSL will use the methods prescribed in Table 4-4, or approved equivalents, for the determination of metals and general chemistry parameters required by the AWWT WAC or related AWR Contract technical requirements. Results from the testing of parameters related to the AWWT WAC will be used in determining whether or not the wastewater can be discharged to the FEMP AWWT facility. Results of the remaining parameters are to be reported to Fluor Fernald in accordance with the TRD of the AWR Contract.

3157

Table 4-4. Analytical Methods for Metals and General Chemistry Parameters

Parameter	Analytical Method
Metal	
Arsenic	6010B[1]
Barium	6010B[1]
Cadmium	6010B[1]
Chromium	6010B[1]
Iron	6010B[1]
Lead	6010B[1]
Mercury	7470A[1]
Selenium	6010B[1]
Silver	6010B[1]
General Chemistry	
Total suspended solids	160.2[2]
Chloride[3]	325.1[2]
Nitrate[3]	352.1[2]
Carbonate (Hardness)[3]	130.1[2]
Sulfate[3]	375.1[2]

Notes: [1] *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, EPA Report Number SW-846 (EPA 1998), specifies test methods and detection limits.
[2] *Methods for Chemical Analysis of Water and Wastes*, EPA Report Number 600/4-79-020 (EPA 1979) specifies test methods and detection limits.
[3] Parameter is required to be monitored and reported in accordance with AWR Contract *Technical Requirements Document*, Document No. 40710-RP-0001, Feb. 3, 1999, Rev. 1.

4.2 Air Emissions

RCS stack air emissions will be sampled and continuously monitored using isokinetic sampling to ensure a representative composite particulate sample is obtained. The isokinetic sampler will be inspected and the filter changed as described below. The air emissions will also be monitored for radon. Refer to Appendices D and E of this Plan for proposed air emissions analyses and sampling guidelines, respectively.

4.2.1 Stack Monitoring

The RCS stack must be continuously monitored as required by the Clean Air Act (CAA) regulations (40 CFR 61) and DOE Order 5400.5. The continuous monitor serves two functions: (1) to collect a sample of the stack gas for measurement of the concentration of radon, and (2) to collect a representative sample of particulates to assess the concentrations of other radionuclides and toxic chemicals (e.g., lead) present. An isokinetic sampler meeting American National Standards Institute (ANSI) N13.1-1969 is required to get a representative sample of particulates. The same sampling system will be used to collect the air sample for radon, although the isokinetic feature is not necessary.

The isokinetic sample system consists of the following:

- Sampler head,
- Particulate sampler,
- Sample line,
- Particulate radiation detector,
- Radon detector,

- Sample flow measurement device,
- Sample flow controller,
- Control system,
- Pump, and
- Return line.

Sampler Head. The sampler head is inserted into the stack approximately eight diameters after the RCS exhaust air (which enters at a higher elevation than the building ventilation air) enters the stack and approximately two stack diameters before the diameter is reduced.

Particulate Sampler. The sampler consists of tube with six nozzles arranged to collect air from different locations in the stack. Devices to measure stack flow and temperatures are also attached to the sampler.

Sample Line. The sample line is a two-inch line that exits the stack and runs down to near ground level where the remainder of the system is located. To minimize particulate line losses, the bends in the line are made with a radius of approximately 20 inches, the inside surface of the line is selected for smoothness, and the length of horizontal runs is minimized. The sample line runs from the sampler in the stack to a small Monitor Building at ground level that houses the rest of the sampler system.

Particulate Radiation Detector. The particulate radiation detector is discussed in the paragraph entitled "Particulate Monitoring" of this section.

Radon Detector. The radon detector is discussed in the paragraph entitled "Radon Monitoring" of this section.

Sample Flow Measurement Device. A sample flow measurement device is located in the equipment console and serves to measure the airflow rate in the sample line. The sample flow controller, also located in the console adjusts the flow in the sample line to maintain isokinetic-sampling conditions (i.e., the linear velocity in the stack air equals the linear velocity of air entering the sampler). This flow control is achieved through the control system.

Control System. The control system collects measurement signals for the stack flow, the sample loop flow, the particulate detector and the radon detector for processing and control. The control loop serves to automatically adjust the sample flow rate to maintain isokinetic-sampling conditions. The signals are transmitted to the AWR Project control trailer and recorded. An alarm point is provided to indicate when isokinetic-sampling conditions are not maintained. Detector alarms are discussed in the respective paragraphs for particulate and radon monitoring in this section.

Pump. The pump, also located in the Monitor Building, is the motive force for pulling air from the stack and through the sampling system. The pump is sized to so that the system can compensate for the possible buildup of material on the particulate filter.

Return Line. The exhaust from the pump is returned to the bottom of the stack through the return line. This line requires no special features, but will be designed to minimize pressure losses in order to enhance pump life.

3157

In addition to the real time monitoring of particulate radioactivity and radon concentration, the filter paper sample is changed weekly, bi-weekly (or monthly, if justified by DQOs) and the monitor is inspected at that time. Approved DOE or EPA sampling and analytical methods must be followed in the field and by the CSL. Both typical and alternative analytical methods to be used by the CSL are presented in Appendix D of this Sampling Plan.

Further explanation relating to the use of field monitoring methods for radon and particulate emissions is provided below. The sampling guideline for RCS stack is provided in Appendix E of this Plan. Collection, handling, and shipment of samples will be performed according to approved AWR Project procedures, ALARA practices, and applicable DOT shipping guidelines.

Radon Monitoring –
Radon concentrations in the RCS air effluent will be measured in the RCS stack. The type of monitor to be used will be a continuous monitor such as a Pylon AB5 Radon Measurement System, or equivalent. The Pylon monitor will have the capability to draw in a sample of air from the stack and give a real-time measurement of the radon concentration present.

The "High" alarm will be set at 2,000 pCi/L, and the "High-High" alarm will be set at 6,000 pCi/L. A concentration of 6,000 pCi/L in the stack airflow of 10,300 cubic feet per minute (cfm) corresponds to an instantaneous onsite concentration of 0.15 working levels (WL), which is the "worst-case" concentration, and a maximum annual offsite concentration of 0.015 pCi/L (if maintained at 6,000 pCi/L for the entire year).

Particulate Monitoring –
For particulate monitoring of RCS air effluent, the type of isokinetic sampler to be used in the RCS stack is an EG&G Berthold Alpha in Air Aerosol Monitor LB 150 R, or equivalent. The sampler will have the capability to draw an isokinetic sample from the stack, pass the sample through a filter paper and then to analyze the alpha emissions from the particulate material collected. The measurement technique is able to distinguish between alpha radiation emitted by short-lived radon daughters (5.45 to 7.69 MeV) and that emitted by long-lived radionuclides like Th-230 (4.68 MeV). The monitor "High" alarm will be set at a particulate concentration of 1×10^{-12} µCi/mL. This concentration corresponds to an offsite dose rate of less than 0.1 mrem/year. The "High-High" alarm will be set at 5×10^{-12} µCi/mL.

In addition, the semi-annual analysis of the filter paper composite will include the analysis of lead to demonstrate compliance with the regulatory standard for lead in ambient air (0.1 $\mu g/m^3$) referenced in OAC 3745-31-05(A)(3). The maximum concentration of lead in air is calculated from the weight of lead collected by the continuous monitor, the ratio of stack flow-to-sample flow, and the atmospheric dispersion calculated by EPA CAP88 modeling.

4.2.2 Radon Process Monitoring

As previously described in Section 3.2.2, radon concentrations will be measured in six locations for process monitoring as part of the AWR Project. Four of these monitoring locations are immediately downstream of each of the four carbon bed filters for use in assessing RCS process operations. The other two monitoring locations will be in the ductwork upstream of the carbon beds, before and after the junction of the inlet ducts from the silos, TTA, and future process facilities. These measurements serve to assess the concentration of radon in the silo headspaces and before adsorption. Comparisons between the concentrations before and after adsorption give a measure of the effectiveness of the carbon beds.

The type of monitor to be used downstream of each carbon bed filter will be a continuous monitor such as a Pylon AB5 Radon Measurement System, or equivalent. The Pylon monitor will have the capability to draw in a sample of air from a duct to be assessed and give a real-time measurement of the radon concentration present. Since this radon process monitoring is real-time in nature and not part of the air emissions monitoring for the RCS stack, it is not specifically addressed by the sampling guideline provided in Appendix E of this Sampling Plan.

4.3 Silo Residues

Samples of silo residues will be collected and archived for future testing and analysis as determined by Fluor Fernald, and therefore, this Sampling Plan only summarizes the proposed sampling methodology and does not specifically address the testing or analysis of the collected silo residues. Detailed sampling procedures will be prepared as part of the operating procedures for the TTA (i.e., *AWR SOPs*, Submittal No. 624-P6315-01 for the AWR Project).

To sample the silo residues stored in the TTA Transfer Storage Tanks, a mobile percussion hammer-coring machine will be operated from a portable enclosure located on the TTA Equipment Deck. This methodology involves a dual tube sampling system for extracting samples from the TTA Transfer Storage Tanks. The system consists of two sets of probe rods used to collect continuous core samples. One set of rods, consisting of 4-foot sections of 2-inch probes (approximate), is driven into the residues as an outer casing. These rods receive the driving force from the hammer and provide a sealed hole from which residue samples may be recovered without the threat of cross-contamination. The second, smaller set of 1-inch rods (approximate) hold a sample liner in place as the outer casing is driven one sampling interval (i.e., 4 feet). The small rods are then retracted to retrieve the sample-filled liner. This process is continued for the entire depth of the tank, with the equipment being appropriately decontaminated each time the samples are retrieved.

Approximately two gallons of silo residues can be retrieved for a full-depth core from a TTA Transfer Storage Tank. The sampling module (i.e., mobile coring machine and portable enclosure) will be required to core the maximum allowable depth in the storage tanks a minimum of 75 times to retrieve the required quantity of silo residues (i.e., 150 gallons). With three nozzles in each of the four TTA tanks, the sampling module will have to extract approximately 12½ gallons from each nozzle. The sampling module will be moved as required to accomplish the sampling effort for all four tanks.

After the residues are collected from the tank nozzle, the liners will be removed from the probes and decontaminated. The cores will also be checked for free liquids and transferred to 5-gallon pails. The pails will then be transferred to a 55-gallon drum, which holds a maximum of three pails, and the drum will be transferred to a nearby shielded area on the TTA Equipment Deck for storage.

5.0 DOCUMENTATION AND RECORDKEEPING

3157

Records management for the AWR Project will be conducted in accordance with the *Records Management Plan*, Document No. 624-P621-04, and related AWR Project procedures. Additional information is provided in this section related specifically to the documentation and recordkeeping associated with the sampling efforts for the AWR Project.

5.1 Field Logbook

A field logbook shall be maintained and shall document the sampling activities associated with collecting wastewater and air emissions samples for the AWR Project. This logbook will be a bound book with no loose pages. Entries shall be made in permanent waterproof black ink. No pages shall be removed from the logbook for any reasons. If corrections are necessary, then they shall be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside.

The logbook shall include the date of the sampling activity, AWR Project personnel collecting the sample, source of the sample media, sample identification designation, time of collection, analysis to be performed, preservatives (as required), and any other information necessary to process the sample or to recreate the sampling event.

5.2 Sample Container Labeling

Each sample will be labeled, chemically preserved (if required), sealed immediately after collection, and placed on ice or refrigerated (if required). To minimize handling of sample labels, labels will be completed prior to sample collection. The sample container label will be filled in using waterproof ink and will be firmly affixed to the sample containers and protected by clear tape.

At a minimum, each sample will have a sample label or tag containing the information in the following list:

- Project name,
- Sample identification,
- Date of sample collection,
- Time of sample collection,
- Analyses to be performed,
- Preservatives, and
- Initials of individual collecting the sample.

5.3 Sample Packaging and Shipping

Samples will be packaged in leak-proof zip-lock bags and sealed to contain accidental spillage. Bags containing samples may be packaged in a second bag or cooler containing wet ice if required by the specific preservative requirements for analysis. The second bag or cooler will be sealed to prevent leakage.

Samples to be shipped to an offsite laboratory (i.e., CSL) will be packaged and shipped in a U.S. Department of Transportation (DOT)-approved container, which is provided by the CSL for that purpose. Prior to packaging, shipping containers will be scanned by radiological control personnel to ensure the external surface of the containers is within DOE Order 5400.5 free release criteria. Assurance must be made that the container is shipped in accordance with DOT requirements. Material is considered radioactive by the DOT at $\geq$ 2 nCi/g. Any container exceeding the free release criteria limit will be rejected for shipment and corrective measures will be taken before the samples are shipped. Samples will be shipped for overnight delivery.

5.4 Chain-of-Custody (COC)

For samples shipped for analysis, a COC form will be completed by a designated field team member responsible for sample custody and signed off by the receiving laboratory. As a matter of record, a COC will be prepared for samples collected and analyzed onsite and not processed for shipment offsite. Information specified on the COC record will contain the same level of detail as found in the field logbook. The custody record bill includes the following information:

- Site name;
- Names of the PM and the personnel responsible for collection of the listed sample;
- Sample identification;
- Date and time each sample was collected;
- Type of sampling conducted (composite/grab);
- Number of sample containers shipped;
- Analyses requested;
- Sample preservation information;
- Name of carrier used to ship the samples and a bill of lading or air bill number; and
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted, and of the designated sample custodian at the receiving facility.

In addition, if samples are known to require rapid turnaround because of project time constraints or analytical concerns (e.g., extraction time or sample retention period limitations, etc.), then the person completing the COC record will note these constraints in the remarks section of the custody record. The relinquishing individual will record shipping data (e.g., air bill number, organization, time, and date) on the original COC record, which will be transported with the samples to the laboratory and retained in the laboratory's file. A COC guideline (including a typical sample tag, seal, and COC form) to be used for the AWR Project is provided in Appendix F of this Sampling Plan.

5.5 Records Storage

Sampling activities will be recorded in the field logbook, which will be maintained in the field office. Copies of COC forms, as well as analytical data from field screening and from the laboratory, will be retained by AWR Project document control. AWR Project records storage will be conducted in accordance with the *Records Management Plan* and related AWR Project procedures.

5.6 Analytical Data

3157

This section provides information related to the required analytical laboratory documentation levels and analytical turn-around times for air and water samples collected as part of the AWR Project.

5.6.1 Wastewater Samples

For wastewater samples, the CSL is to provide a data package consistent with the QA/QC requirements of the CSL's approved Quality Assurance (QA) Program (ASTM 1992). It is anticipated that the CSL will meet the FEMP-defined analytical level of "Analytical Support Level (ASL) E" (non-standardized protocols) for the parameters listed in Appendix B of this Sampling Plan. Field screening will meet the FEMP-defined analytical level "ASL A", which provides qualitative field analyses.

Data validation will be conducted in accordance with Foster Wheeler Environmental Corporation (FWENC) Corporate Procedure SCG-201, *Organic and Inorganic Data Validation.* Analytical laboratory audits will be conducted to assess CSL performance in accordance with FWENC Corporate Procedure SCI-006, *Analytical Laboratory Audits.* Analytical turn-around times will vary upon request, depending on the specific time requirement for transferring wastewater from the AWR Project facilities to the AWWT. If needed, a 48-hour turn-around time will be requested for analytical results.

5.6.2 Air Emission Samples

For radon process monitoring (both upstream and downstream of the carbon beds), this monitoring will meet the FEMP-defined analytical level "ASL A", which provides qualitative field analyses. Foster Wheeler will ensure that the radon monitors are calibrated in accordance with manufacturer's requirements and at the established frequencies and that measurements of radon concentrations are recorded and reviewed at a frequency sufficient to detect performance trends and/or situations requiring mitigation. Radon monitoring for the stack will also meet the FEMP-defined analytical level of "ASL E".

For air emission monitoring, the isokinetic particulate filter sample is collected once per two weeks (or a month if justified) for the analysis of long-lived alpha and beta emitters (see Appendix D of this Sampling Plan). The initial/ending sampling dates and times, sample volume, and stack flow for that period of time are recorded. The CSL data package should be received within a 30-day turnaround time period.

The filter paper from the particulate stack monitor is essentially analyzed three times. The in-line monitor will meet the FEMP-defined analytical level of "ASL A", which provides qualitative field analyses (for radionuclides only). The bi-weekly onsite or CSL analysis will meet the FEMP-defined analytical level of "ASL E", and the semi-annual composites are also considered "ASL E" (non-standardized protocols), subject to concurrence by Fluor Fernald.

Data validation will be conducted in accordance with FWENC Corporate Procedure SCG-201, *Organic and Inorganic Data Validation.* Analytical laboratory audits will be conducted to assess CSL performance in accordance with FWENC Corporate Procedure SCI-006, *Analytical Laboratory Audits.*

6.0 WASTE MANAGEMENT

Minimal amounts of waste are anticipated from the sampling activities associated with the AWR Project. A time-phased estimate of secondary waste generation has been prepared for the entire AWR Project, including the waste from sampling activities as described in this section, and is contained in Document No. 624-P622-22, *Timed Estimate of Secondary Waste*, and Document No. 624-ACR007-01, *Waste Handling Work Plan*. In addition, Fluor Fernald has prepared a *Waste Management Plan* for the AWR Project.

6.1 Wastewater

Wastewater generated during the sampling activities (e.g., line purge water, rejected samples, etc.) will be returned to the waste transfer process. No segregated wastewater will be stored or discharged onsite.

6.2 Consumables

Consumables (e.g., gloves, PPE, etc.) will be disposed of in accordance with the *Waste Management Plan*, the *Waste Handling Work Plan*, and related FEMP site procedures. Attachments to the *Waste Management Plan* include the Project Waste Identification and Disposition (PWID) Report and Material Segregation and Container-ization Criteria (MSCC). These documents allow for the tracking and containerization of waste for the AWR Project.

7.0 REFERENCES

3157

Table 7-1 provides a list of the FEMP plans and procedures consulted in the preparation of this Plan.

Table 7-1. List of Referenced FEMP Plans and Procedures

Number	Title
EP-0005	Controlling Wastewater Discharges into the FEMP Wastewater Treatment System
EP-0010	Responding to Stack Monitoring Alarms
EW-0002	Chain of Custody/Request of Analysis Record for Sample Control
EW-0012	Tank/Sump Contents Removal
EW-1021	Preparation of PWID Report
FD-1000	Sitewide CERCLA Quality Assurance Project Plan
PT-0005	Packaging Low Level Radioactive Waste (LLRW) in Drums
PT-0007	Packaging LLRW in Metal Boxes
PT-0009	Collection of Contaminated Trash for Disposal
PT-0014	FEMP Approved Packaging and Shipping Containers
PT-0018	Preparation of Document for Offsite Shipment of Hazardous Materials
RP-0009	Radiological Requirements for the Release of Materials at the Fernald Environmental Management Project
RP-0010	Identification and Movement of Radioactive Materials
RP-0017	Liquid Radioactive Standards Survey Requirements
PL-0002	AWR Project Waste Management Plan

Other references used in the development of this Plan include:

American Public Health Association, American Water Works Association, and Water Environment Federation, *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998.

American Society of Testing and Materials, *"Standard Practice for Generation of Environmental Data to Waste Management Activities: Quality Assurance and Quality Control Planning and Implementation"*, 1992, ASTM D 5283-92.

American Society of Testing and Materials, *"Standard Practice for Generation of Environmental Data to Waste Management Activities: Development of Data Quality Objectives"*, 1995, ASTM D 5792-95.

Code of Federal Regulations, Title 40, Part 61, Appendix B, *"Method 114 – Test Methods for Measuring Radionuclide Emissions from Stationary Sources"*.

U.S. Environmental Protection Agency, *"Methods for Chemical Analysis of Water and Wastes"*, EPA 600/4-79-020, 1979.

U.S. Environmental Protection Agency, *"Prescribed Methods for Measurement of Radioactivity in Drinking Water"*, EPA-600/4-80-032, August 1980.

U.S. Environmental Protection Agency, *"Determination of Lead-210 in Drinking Water, Method 909.0"* (May 1982) and *"Determination of Polonium-210 in Drinking Water by Alpha Particle Counting, Method 912.0"* (October 1983), EPA Region I Library Local Call Number 01A0004860.

U.S. Environmental Protection Agency, *"Test Methods for Evaluating Solid Waste Physical/Chemical Methods"*, 1998, EPA SW-846.

Foster Wheeler Environmental Corporation (FWENC) Corporate Procedure SCI-004, *Sample Preservation, Chain of Custody, Packaging and Shipping*, 1996.

FWENC Corporate Procedure SCG-201, *Organic and Inorganic Data Validation*, 1996.

FWENC Corporate Procedure SCI-006, *Analytical Laboratory Audits*, 1998.

3157

APPENDICES

APPENDIX A

Advanced Wastewater Treatment Facility (AWWT) Waste Acceptance Criteria (WAC) for the Accelerated Waste Retrieval (AWR) Project

Parameter	Discharge Limit (pCi/L)[1]		
Radionuclide			
Actinium – 227 (Ac-227)	10		
Lead – 210 (Pb-210)	30		
Polonium – 210 (Po-210)	80		
Protactinium – 231 (Pa-231)	10		
Radium – 226 (Ra-226)	100		
Radium – 228 (Ra-228)	100		
Thorium – 228 (Th-228)	400		
Thorium – 230 (Th-230)	300		
Thorium – 232 (Th-232)	50		
Uranium – 234 (U-234)	5 ppm		
Uranium – 235/236 (U-235/U-236)			
Uranium – 238 (U-238)			
Metal	**kg/day[1]**	**lb/day[1]**	**ppm[1,2]**
Arsenic (As)	0.14	0.3	5
Barium (Ba)	2.7	6.0	100
Cadmium (Cd)	0.006	0.013	0.22
Chromium (Cr)	0.14	0.3	5
Iron (Fe)	0.03	0.06	1
Lead (Pb)	0.03	0.07	1.2
Mercury (Hg)	0	0	0
Selenium (Se)	0.03	0.06	1
Silver (Ag)	0.0014	0.003	0.05
General Chemistry			
Total suspended solids (TSS)	1,000 ppm		

Notes: [1] pCi/L = picocuries per liter; ppm = parts per million; kg/day = kilograms per day; lb/day = pounds per day.
[2] Concentration calculated assuming maximum allowable flow of 7,200 gpd in accordance with AWWT WAC.

APPENDIX B

3157

Summary of Analytical Procedures, Containers, Preservatives, and Holding Time Requirements for Wastewater Samples

Radionuclides				
Parameter	**Analytical Procedure[1]**	**Holding Time**	**Preservative Requirements**	**Number/Type Containers Per Sample**
Ac-227	Ga-01 and A-01-R	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Pb-210	Pb-01-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Po-210	Po-01-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Pa-231	Ga-01 and A-01-R	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Ra-226	Ra-06-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Ra-228	Th-01-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Th-228	Th-01-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Th-230				
Th-232				
U-234	U-02-RC	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
U-235/236				
U-238				
Gross alpha	A-01-R	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Gross beta	B-01-R	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Gamma isotopic	Ga-01-R	1-Year	HNO_3 to pH < 2	1-1Liter Plastic or Glass

Metals				
Parameter	**Analytical Procedure[1]**	**Holding Time**	**Preservative Requirements**	**Number/Type Containers Per Sample**
As	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass
Ba	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Cd	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Cr	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Fe	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Pb	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Hg	7470A	28-Days	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Se	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]
Ag	6010B	6-Months	HNO_3 to pH < 2	1-1Liter Plastic or Glass[2]

General Chemistry				
Parameter	**Analytical Procedure[1]**	**Holding Time**	**Preservative Requirements**	**Number/Type Containers Per Sample**
TSS	160.2	7-Days	Cool to 4 °C	1-100 ml Plastic or Glass
Chloride	325.1	7-Days	None Required.	1-50 ml Plastic or Glass
Nitrate	352.1	24-Hours	Cool to 4 °C	1-100 ml Plastic or Glass
Carbonate (Hardness)	130.1	6-Months	Cool to 4 °C, HNO_3 to pH < 2	1-100 ml Plastic or Glass
Sulfate	375.1	7-Days	Cool to 4 °C	1-50 ml Plastic or Glass

Notes:
[1] EPA procedures specify test methods and detection limits.
[2] Extracted into same sample container as Arsenic.

APPENDIX C

Accelerated Waste Retrieval (AWR) Project Sampling and Analysis Guidelines

SUBJECT: WASTEWATER SAMPLE COLLECTION GUIDELINE

I. Scope and Application

This guideline applies to wastewater samples collected for the AWR Project at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. The goal of this guideline is to ensure that the wastewater samples collected from either of the two condensate tanks or the filtrate storage tank are representative of the wastewater scheduled for discharge into the Advanced Wastewater Treatment (AWWT) facility. Detailed procedures for collecting wastewater samples for the AWR Project are to be developed as part of *the Radon Control System (RCS) Phase 1 and 2 Standard Operating Procedures* (SOPs), AWR Project Submittals 624-P633-01 and 624-P636-01, respectively, and the *AWR SOPs* (Submittal No. 624-P6315-01).

II. Summary

This guideline outlines the requirements for the collection of wastewater from the two RCS condensate tanks and the Transfer Tank Area (TTA) filtrate storage and ensures that the samples collected are representative of wastewater to be released to the AWWT. Samples will be collected in a timely manner and with such care to avoid resampling, thus minimizing potential delays to the AWR Project.

III. Equipment

The following equipment shall be necessary for the collection of wastewater samples from the condensate tanks and TTA filtrate storage tank:

A. Container(s) to collect purge wastewater (pre-sampling);
B. Sample containers with labels;
C. Preservatives as applicable, and
D. Spill containment materials.

IV. Safety

Only AWR Project personnel trained in accordance with the *Project Specific Health and Safety Plan* (HASP) will be allowed to perform or participate in the collection of wastewater samples. Refer to SOPs and Radiation Work Permit for details regarding the appropriate training and level of personal protective equipment (PPE) required for sampling.

V. Procedure Guide

A. RCS Condensate Tanks – Perform the following:

1. Locate the tap or sampling port for the tank to be sampled.

3157

2. Barricade or otherwise prevent access to the area by unauthorized personnel during sampling.

3. Place a polyethylene ground cover under the sampling port to contain spillage.

4. Place a dedicated and metered container beneath the sampling port to collect purge or pre-sampled wastewater.

5. Purge or evacuate wastewater from the line between the tank and the sampling port. This line volume shall consist of wastewater contained in the line between the tank and the sampling port and shall be determined based on post-construction measurements.

6. Collect a sufficient volume of wastewater, based on laboratory recommendations, in clean sample containers. As appropriate, the containers shall already contain the preservative.

7. Return the purged wastewater back into the waste transfer system.

8. Close valves to prevent accidental release of wastewater from the line.

9. Complete sample container labeling per Manual Chain-of-Custody (COC) Procedures.

10. Store dedicated purge wastewater container in predetermined location.

11. Dispose of polyethylene sheeting.

12. Remove area barricades.

13. Process samples per Manual COC Procedures.

B. TTA Filtrate Storage Tank – Perform the following:

1. Locate the tap or sampling port.

2. Barricade or otherwise prevent access to the area by unauthorized personnel during sampling.

3. Place a polyethylene ground cover under the sampling port to contain spillage.

4. Place a dedicated and metered container beneath the sampling port to collect purge or pre-sampled wastewater.

5. Recirculate tank contents equivalent to one tank volume (i.e., 7,500 gallons). Purge or evacuate the line between the filtration system and the sampling port. This line volume shall consist of wastewater contained in

the line between the filtration system and the sampling port and shall be determined based on post-construction measurements.

6. Collect a sufficient volume of wastewater, based on laboratory recommendations, in clean sample containers. As appropriate, the containers shall already contain the preservative.

7. Return the purged water back into the waste transfer system.

8. Close valves to prevent accidental release of wastewater from the line.

9. Complete sample container labeling per Manual COC Procedures.

10. Store dedicated purge wastewater container in predetermined location.

11. Dispose of polyethylene sheeting.

12. Remove area barricades.

13. Process samples per Manual COC Procedures.

VII. Quality Control/Quality Assurance

The bound field logbook will be maintained by the Project Manager or his designee when not in the possession of the field sampling team. The logbook shall detail each sampling event in reproducible detail. Entries shall be made in black, indelible ink, each page signed, and dated. Subsequent corrections shall be made by a single line drawn through the original entry, entry of the corrected information, and initialing and dating by the individual making the correction. Copies of field logbooks will be retained and become part of the completed project records in accordance with the AWR Project *Records Management Plan.*

APPENDIX D

3157

Typical and Alternative Analytical Methods for Air Emissions Analyses

Typical Analytical Methods for Air Emissions Analyses

Parameter	Analytical Method[1]
Metals	
Pb	7000A[2]
Radionuclide	
Ac – 227	G-01[3]
Pb – 210	Pb-01-RC[3]
Po – 210	Po-02-RC[3]
Pa – 231	G-01[3]
Ra – 226	Ra-02-RC[3]
Th – 230	Th-01-RC[3]

Notes: [1] For radionuclides, method or approved equivalent must comply with Method 114 of 40 CFR 61, Appendix B, *Test Methods for Measuring Radionuclide Emissions from Stationary Sources.*
[2] *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, EPA Report Number SW-846 (EPA 1998), specifies test methods and detection limits.
[3] EML procedure specifies test methods and detection limits, as provided in the *Procedures Manual of the EML*, HASL-300.

Alternative Analytical Methods for Air Emissions Analyses

Parameter	Analytical Method[1]
Radionuclide	
Gross alpha	A-01-R[2]
Gross beta	Ba-01-R[2]
Gamma isotopic	Ga-01-R[2]

Notes: [1] For radionuclides, method or approved equivalent must comply with Method 114 of 40 CFR 61, Appendix B, *Test Methods for Measuring Radionuclide Emissions from Stationary Sources.*
[2] EML procedure specifies test methods and detection limits, as provided in the *Procedures Manual of the EML*, HASL-300.

APPENDIX E

Accelerated Waste Retrieval (AWR) Project Sampling and Analysis Guidelines

SUBJECT: AIR EMISSIONS MONITORING – RADON CONTROL SYSTEM (RCS) STACK SAMPLING GUIDELINE

I. Scope and Application

This guideline applies to air emission samples collected for the AWR Project at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. Specifically, this guideline describes air emission monitoring for radioactive particulate matter using isokinetic sampling to ensure a representative composite particulate sample is obtained from the RCS. The isokinetic filter sample will be continuously monitored and collected bi-weekly (or monthly if justified) for analysis. Detailed procedures for conducting air emission monitoring for the AWR Project are to be developed as part of *the RCS Phase 1 and 2 Standard Operating Procedures* (SOPs), AWR Project Submittals 624-P633-01 and 624-P636-01, respectively,

II. Summary

Air is drawn into a covered housing and passed through a filter using a high-flow suction motor. Airborne particulate matter is collected on the filter. The flow rate of the air is measured along with a measurement of the sample airflow rate. An automatic controller ensures that the proper ratio is maintained to achieve isokinetic-sampling conditions. The sample is monitored continuously by an alpha-sensitive detector. The filter sample is removed every two weeks (or monthly if justified) and analyzed to quantify the amount and type of radioactivity released. Method or approved equivalent must comply with Method 114 of Title 40 of the Code of Federal Regulations (CFR) Part 61, Appendix B, *Test Methods for Measuring Radionuclide Emissions from Stationary Sources.*

A number of interferences can bias the sampling results. Factors such as vapors, insects, large particles, heavy dust, and moisture can overload the filter and reduce the flow rate across the face of the filter.

III. Equipment

A. Isokinetic sampler;
B. EG&G Berthold Alpha in Air Aerosol Monitor LB R, or equivalent;
C. Filter (pre-weighed); and
D. Flow Rate Recorder.

IV. Safety

Only AWR Project personnel trained in accordance with the *Project Specific Health and Safety Plan* (HASP) will be allowed to perform or participate in the collection of wastewater samples. Refer to SOPs and Radiation Work Permit for details regarding

the appropriate training and level of personal protective equipment (PPE) required for sampling.

V. Procedure Guide

3157

A. RCS Stack – Perform the following:

1. Calibrate the sampler per manufacturer's instructions and record the calibration in the logbook.
2. Use filters of predetermined weight.
3. Mount the filter in the filter holder and clamp onto the sampler.
4. Start the sampler pump and record the time.
5. Record the initial flow rate, temperature, and barometric pressure.
6. Run sample collection for the length of time specified, generally two weeks (or monthly if justified), but monitored continuously.
7. Take intermediate readings of flow rate, temperature, and barometric pressure and record in the logbook.
8. Take final readings of flow rate, temperature, and barometric pressure prior to filter retrieval.
9. Carefully remove the filter using gloves and forceps and fold it up to collect material on the filter. Place in an appropriate sample container.
10. Label and package sample in accordance with Manual Chain of Custody (COC) Procedures.
11. Install new filter (as in Step 3).
12. Complete field logbook entries.

VII. Quality Control/Quality Assurance

The bound field logbook will be maintained by the Project Manager or his designee when not in the possession of the field sampling team. The logbook shall detail each sampling event in reproducible detail. Entries shall be made in black, indelible ink, each page signed, and dated. Subsequent corrections shall be made by a single line drawn trough the original entry, entry of the corrected information, and initialing and dating by the individual making the correction. Copies of field logbooks will be retained and become part of the completed project records in accordance with the AWR Project *Records Management Plan.*

APPENDIX F

Accelerated Waste Retrieval (AWR) Project Sampling and Analysis Guidelines

SUBJECT: MANUAL CHAIN-OF-CUSTODY (COC) GUIDELINE

I. Scope and Application

This chain-of-custody (COC) guideline applies to wastewater and air emission samples collected for the AWR Project at the U.S Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. The goal is to ensure the integrity of the samples from collection to final disposition by documenting possession. COC documentation will trace possession of samples from their collection through transfers of custody until final disposition, including archiving where required. This guideline can be developed into a formal procedure for use during the AWR Project, or a FEMP COC procedure could be adopted. This guideline excludes the K-65 material collected and archived for future testing.

II. Summary

COC is a process for the tracking of samples. The components of this COC guideline include sample labels or tags, sample or custody seals, field logbooks, COC records, sample requests for analysis, and shipping/transport information. Each document is filled out to transmit appropriate data and to track the sample.

This guideline will be applied to samples collected during operation and maintenance (O&M) of the AWR Project, including air emissions and wastewater samples. This guideline does not apply to the transfer of samples between sampling team members. The project designation and sampling event may be eliminated from the label and documented in a logbook if necessary to transmit blind quality control samples.

III. Equipment

A. Sample labels or tags;
B. Sample or custody seals;
C. Field logbook;
D. COC form;
E. Sample request for analysis; and
F. Black indelible ink pen.

IV. Safety

Only AWR Project personnel trained in accordance with the *Project Specific Health and Safety Plan* (HASP) will be allowed to perform or participate in the collection of wastewater samples. Refer to applicable Standard Operating Procedure (SOP) and Radiation Work Permit for details regarding the appropriate training and level of personal protective equipment (PPE) required for sampling.

V. Procedure Guide

3157

A. Samples under Custody – COC requirements are necessary whenever a sample leaves the sampling teams' custody. A sample is considered to be under a person's custody if any of the following conditions are met:

1. The sample is in the person's physical possession.
2. The sample is in the line-of-sight of the person after he/she as taken possession.
3. That person secures the sample so any tampering can be detected.
4. A sample is secured by the person in possession in an area that only authorized personnel can enter.

B. Sample Labels or Tags – Sample labels or tags will be affixed to sample containers prior to or at the time of sampling. To the extent practicable, sample bottles will be labeled prior to collection. Sample labels will be waterproof paper or plastic with adhesive backs or waterproof tags, as appropriate. *A typical sampling label is provided as an attachment to this guideline.* Labels will be completed with black indelible ink and will include the following information:

1. Sampling activity name and/or number;
2. Sample number to be assigned by the Project Manager or his designee;
3. Sample location, i.e., stack, sampling port, tank, etc.;
4. Sampling date and time;
5. Sample preservation used as applicable;
6. Media sample or sample type;
7. Analyses required; and
8. Special comments as needed.

C. Sample or Custody Seals – Sample or custody seals are used to detect tampering of samples, following sample collection prior to the time of analysis. The seal will be attached in such a way that it is necessary to beak the seal in order to open the sample container. Here, "sample containers" may refer to either individual sample containers or a shipping container. Seals will be affixed to the container before they leave the custody of the sampling personnel. *A typical custody seal is provided as an attachment to this guideline.*

Custody seals will be waterproof paper or plastic with adhesive backs. Samples designated for shipment that leave the sampler's custody will have a sample seal affixed, which includes the following information:

1. Name of collector(s); and

2. Date and time of sealing the container.

D. Field Logbook – A field logbook entry will be made at the time the sample is collected; the entry will be completed at the time the sample is taken. The field logbook entry will include, but not limited to, the following information:

1. Sampling activity name;

2. Sample number to be assigned by the Project Manager or his designee;

3. Name(s) of collector(s) and identification of others present including radiological control personnel;

4. Name and site address of Project Manager or his designee;

5. Date and time of sample collection;

6. Sample location, i.e., stack, sampling port, or tank;

7. Sample media (e.g., water, air particulate, etc.)

8. Analytical parameter(s) to be measured;

9. Preservatives as appropriate;

10. Location of sampling point;

11. Designation of QC samples (e.g., blank and duplicates);

12. Sampling methodology;

13. Observations during sampling;

14. COC control number and sample request documentation;

15. Sample distribution and method of shipping;

16. Initials of responsible observer; and

17. Field observations and measurements including radiological scans of containers.

E. COC Records – The sampling personnel will complete the COC record at the time of the sampling event. *A typical COC record form is attached to this guideline.* The records will be signed as relinquished or received each time the sample changes possession, from the collection to final disposition. The COC record will include the following information:

1. Sampling activity name;

3157

2. Sample number to be assigned by the Project Manager or his designee;

3. Date and time of sample collection;

4. Name of sample collector(s);

5. Signature(s) of collector or sample custodian;

6. Container type;

7. Preservatives as applicable;

8. Analysis requested;

9. Chain-of-custody control number; and

10. Signature and date blocks for personnel relinquishing or receiving sample custody for the life of the sample (e.g., sample collector, shipper, and receiving laboratory).

F. Sample Request for Analysis Sheet – A request for analysis sheet will be submitted to the lab for the collected samples unless arrangements with the laboratory have been made in writing and acknowledged. The request for analysis sheet will outline the desired analysis for the samples.

VI. Quality Control/Quality Assurance

The bound field logbook will be maintained by the Project Manager or his designee when not in the possession of the field sampling team. The logbook shall detail each sampling event in reproducible detail. Entries shall be made in black, indelible ink, each page signed, and dated. Subsequent corrections shall be made by a single line drawn trough the original entry, entry of the corrected information, and initialing and dating by the individual making the correction. Copies of completed COC records, laboratory request for analysis sheets, completed analytical data, and field logbooks will be retained and become part of the completed project records in accordance with the AWR Project *Records Management Plan.*

Attachment to Manual COC Guideline

SAMPLE TAG OR LABEL (TYPICAL)

SAMPLE NO.:_____
PROJECT:_____
DATE:____/____/____ TIME:_____HRS:_____
MEDIUM: WATER_____ SOIL_____ SEDIMENT_____
OTHER_____ (Specify)
TYPE: GRAB_____ COMPOSITE_____ OTHER_____ (Specify)
PRESERVATION:_____pH:_____
ANALYSIS:_____
SAMPLED BY:_____
LAB NO.:_____
REMARKS:_____
_____

SAMPLE OR CUSTODY SEAL (TYPICAL)

CUSTODY SEAL

Person Collecting Sample:_____
(Print Name)

_____Sample No.:_____
(Signature)

Date Collected:_____ Time:_____

Attachment to Manual COC Guideline

3157

CHAIN-OF-CUSTODY FORM (TYPICAL)

FOSTER WHEELER ENVIRONMENTAL CORPORATION
CHAIN OF CUSTODY RECORD

PROJECT

SAMPLERS: (Signature)

SAMPLE NUMBER	DATE	TIME	COMP	GRAB	NO. CONTAINERS	REMARKS OR SAMPLE LOCATION	ICED	PRESERVATION: SPECIFY CHEMICALS ADDED AND FINAL pH IF KNOWN

Relinquished by: (Signature) ① Date / Time Received by: (Signature)

Relinquished by: (Signature) ② Date / Time Received by: (Signature)

Relinquished by: (Signature) ③ Date / Time Received by: (Signature)

Relinquished by: (Signature) ④ Date / Time Shipped via:

Received for Laboratory by: (Signature) Date / Time Shipping Ticket No.

Remarks

E - 3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BERM EXCAVATION PLAN

DOCUMENT 624-P621-11, Rev. C

FOR THE

SILOS 1 AND 2
ACCELERATED WASTE RETRIEVAL PROJECT

SUBMITTED TO:

FLUOR FERNALD, Inc.

CONTRACT FSC 624

June 21, 2000

CONTENTS

3157

1.0 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope of Work 1
1.3 Background Brief 1
1.4 Radiological Surveys 2
1.5 General Description of Excavation Activities 2
1.6 Environmental Protection Measures 3
1.7 Safe Work Plan 4
2.0 EXCAVATION Plan 5
2.1 General Excavation Activities 5
2.2 Phase 1–Foundation Excavations Adjacent to Silos 1 and 2 5
2.3 Phase 2A and Phase 2B–Operational Excavation 5

APPENDIX A: ATTACHED DRAWINGS
11FCD003, Silo Waste Retrieval System – Excavation Plan, Phase 1
11FCD004, Silo Waste Retrieval System – Excavation Plan, Phase 2A & 2B
11FCD006, Silo Waste Retrieval System – Cross Section, Sheet 2
11FCD007, Silo Waste Retrieval System – Cross Section, Sheet 3
11FCD008, Silo Waste Retrieval System – Cross Section, Sheet 4
11FCD009, Silo Waste Retrieval System – Erosion Control Plan, Phase 1
11FCD010, Silo Retrieval System – Erosion Control Plan, Phase 2A & 2B

ACRONYMS AND ABBREVIATIONS 3157

ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
AWR	Accelerated Waste Retrieval
BEP	Berm Excavation Plan
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
ECP	Environmental Control Plan
FAT&LC	Fernald Atomic Trades and Labor Council
FEMP	Fernald Environmental Management Project
FSM	Full-Scale Mock-Up
H:V	horizontal:vertical
FWENC	Foster Wheeler Environmental Corporation
SWRS	Silos Waste Retrieval System
WHWP	Waste Handling Work Plan

3157

1.0 INTRODUCTION

The Berm Excavation Plan (BEP) is one of the supporting project plans for the Accelerated Waste Retrieval (AWR) Project at the Fernald Environmental Management Project (FEMP) site. This project is located approximately 15 miles northwest of Cincinnati, Ohio, owned by the U.S. Department of Energy (DOE), and managed by Fluor Fernald Inc. The AWR Project is being performed by Foster Wheeler Environmental Corporation (FWENC) under Fluor Fernald Contract FSC 624.

This section provides introductory information on the purpose, scope of work, background, general description of excavation activities, and environmental protection measures associated with the BEP. Section 2.0 summarizes execution, methods, and procedures for berm excavation, transportation, and disposal activities. Section 2.0 also describes the three excavation phases necessary to support the AWR Project, including any contingency planning when discrete objects are encountered. Berm excavation drawings are included in Appendix A.

1.1 Purpose

The purpose of the BEP is to introduce construction and operational procedures relative to the excavation and removal of containment berms associated with Silos 1 and 2 AWR Project. The BEP emphasizes the excavation methods employed to mitigate the impacts on the silo's structural integrity throughout the AWR construction and operational activities.

1.2 Scope of Work

The primary scope of work for the BEP addresses the excavation of the 3:1 (H:V) berm surrounding Silos 1 and 2 during the waste removal operations. Construction activities include the excavation of foundations for the support structure associated with the Silos Waste Retrieval System (SWRS). The BEP does not include excavation outside of the Silos 1 and 2 areas.

1.3 Background Brief

From 1951 to 1960, DOE produced approximately 6800 cubic meters of K-65 material while processing high-grade uranium ores.

Four concrete silos were built to support the uranium process. Silos 1 and 2 provide the storage of the K-65 material. Silo 3 contains a different type of material; it is not in the scope of this project. Silo 4 was never used for material storage; it will serve as the primary operations center during the Full-Scale Mock-Up (FSM).

The K-65 material currently stored in Silos 1 and 2 contains radionuclides such as radium (the contaminant of concern) and thorium. Radium degrades into several elements, among which is radon. During the first 10 years of service, the silos developed fractures in the exterior concrete surface. Periodic inspections revealed radon gas leaks to atmosphere. Soil berms were placed around the silos to enhance their structural integrity and to reduce the hazards to human health and the environment. These berms were initially sloped at 1.5 to 1 (H:V).

Later, in 1983, the berm slopes were revised to incorporate a slope of 3 to 1 (H:V) in order to mitigate soil erosion. The silo domes were foamed to further reduce the release of radon gas to the atmosphere.

1.4 Radiological Surveys

Based on the US and Ohio EPA's approval of existing berm soil sampling data and sampling requirements in Reference letter number DOE-0455-99, "Proposed Phase II Soil Sampling and Analyses within Soil Remediation Area 7" no additional pre-design sampling is required for OSDF WAC attainment purposes. However to proactively address the potential berm soil contamination from Silo leakage, the berm soil and silos walls will be visually monitored for evidence of silo leakage during all berm excavation as part of normal continuous Fluor Fernald Waste Acceptance Organization (WAO) oversight activities. If evidence of silo leakage is identified, the potentially impacted silo berm material will be removed away from the silos to a designated area for real-time monitoring to determine OSDF WAC status and appropriate disposition. The designated area will be located at a sufficient distance from the silos so that radiation from the silos will not impede the monitoring. Staging of berm soil for OSDF disposal will be resumed after Fluor Fernald WAO has verified that all potentially impacted berm material, as indicated by visual staining, has been removed to the designated location.

If real-time monitoring of the potentially impacted berm soil indicates that the soil meets OSDF WAC, it staged for OSDF disposal in the same manner as other soil. Any berm soil determined, based on the real-time monitoring, to exceed OSDF WAC will be moved from the designated monitoring area to SP-7.

The radiological surveys required for occupational safety and health purposes during berm excavation will be performed by a health physics technician provided by Fluor Fernald, Inc. under the direction of FWENC.

The compliance requirements of the Waste Handling Work Plan (WHWP) (Document 40710-624-ACR007-01) will be met during the excavation work performed under the BEP. The WHWP includes requirements for waste transfer protocols, waste storage containers, and secondary waste that is not contained within the silos. The WHWP will be updated as required to incorporate the final disposal and container requirements determined by the Fluor Fernald-approved Project Waste Identification and Disposition Report (PWID).

Discrete objects may be encountered during the berm excavation, such as abandoned utilities or tools left within the berm during construction. Each object will be managed as directed by Fluor Fernald.

1.5 General Description of Excavation Activities

The berm excavation activities are divided into three phases:

- Phase 1 includes excavation to support construction activities before silo remediation begins.
- Phase 2A includes berm excavation around Silo 1 that occurs during the remediation of Silo 1.
- Phase 2B includes berm excavation around Silo 2 that occurs during the remediation of Silo 2.

During the three phases, Foster Wheeler will excavate approximately 17,400 cubic yards of berm soil around Silo 1 and Silo 2. Table 2-1 shows the approximate volumes of berm excavation for each phase.

Table 2-1. Estimated Volume of during Berm Excavation

Phase	Estimated Volume (cubic yards)
1	11,000
2A	3,600
2B	2,800

The primary factors to be observed during excavation are the maintenance of (1) the structural integrity of the silo walls and (2) as low as reasonably achievable (ALARA) radiation protection for workers.

Foster Wheeler shall visually monitor the structural condition of Silo 1 and Silo 2 during excavation activities. If and when it is determined that the silo condition appears to be unsafe—or is substantially different than described in the contract documents—Foster Wheeler will stop the work and inform Fluor Fernald immediately. Fluor Fernald will evaluate the condition and then provide Foster Wheeler with directions for further action within 24 hours.

Excavation equipment includes a Gradall excavator, a small dozer, a bucket loader, and a tri-axle dump truck. The excavator will perform the bulk of the berm removal. All excavation of berm material will utilize methods that facilitate continuous inspection by Fluor Fernald WAO oversight personnel.

Before Phase 1 excavation begins, an Equipment Exclusion Zone and a Hand Excavation Zone will be marked with wooden stakes and flags. Both zones are established to minimize any impacts of heavy equipment on the silo walls. The Equipment Exclusion Zone and the Hand Excavation Zone for each phase of excavation is shown on Drawings 11FCD003, 11FCD006, and 11FCD007.

The Equipment Exclusion Zone is an area that extends approximately 26 feet from the Silo 1 and 2 walls at the beginning of Phase 1. No heavy equipment is allowed inside this zone. As excavation work progresses, this Equipment Exclusion Zone is gradually reduced, with the approval of the Field Engineer.

The Hand Excavation Zone is an area that extends 2 feet from Silo 1 and 2 walls. All soil within 2 feet of the silo walls will be removed using mechanical means which will not impact the silo walls.

1.6 Environmental Protection Measures

Foster Wheeler shall take all reasonable measures, as described in the AWR contract documents, to protect the environment and the safety of both on-site personnel and the general public in surrounding communities. The guiding principle for these measures is the application

of ALARA goals and compliance with applicable or relevant and appropriate requirements (ARARs). These measures are described in the Environmental Control Plan (ECP), Document 40710-624-P621-10. The ECP includes descriptions and requirements for:

- Air Emissions Control,
- Dust Control,
- Wastewater Control,
- Stormwater Control,
- Erosion Control, and
- Secondary Waste Management.

1.7 Safe Work Plan

To be submitted under separate cover.

3157

2.0 EXCAVATION PLAN

This section describes the procedures to be used for performing the berm excavation, transportation, and disposal in support of the AWR Project. Berm excavation drawings are provided in Appendix A.

2.1 General Excavation Activities

Foster Wheeler will maintain the berms until the project is completed. Any eroded areas will be repaired as soon as weather permits. Upon completion of the project, erosion controls (such as seed and mulch) will be placed on all disturbed areas.

A heavy geotextile (16 ounces per square yard) will be placed on slopes steeper than 2:1 (H:V) to stabilize the slope and to prevent the formation of rills. The geotextile will be peeled back in sections to allow for excavation. Hold-down staples will be used in accordance with the manufacturer's recommendations. Plastic sheeting with sandbags or other weights will be used, as required, in order to keep open excavation surfaces dry.

Excavation of berm material will be continuously monitored by Fluor Fernald WAO to ensure WAC compliance. Any OSDF-prohibited items will be segregated and managed in accordance with WAO direction. The excavated soils will be directly loaded into trailer dump trucks and manifested by Fluor Fernald WAO to the OSDF or SP-7. Two trailers will be used to contain and transport the soil to a location designated by Fluor Fernald. The trucks will be covered for dust control and rain protection.

2.2 Phase 1–Foundation Excavations Adjacent to Silos 1 and 2

During Phase 1, FWENC shall excavate portions of the berm to construct the foundations required for erection of the SWRS Support Structure (see Drawing 11FCD003). Phase 1 excavation and construction activities will be performed by FWENC construction personnel.

The SWRS Support Structure has (1) a fixed, rotating structural support (the turntable) and (2) a movable structure (the bridge) that glides on a concrete runway using air bearings to support the structure's weight and to provide a smooth movement into new positions. Concrete foundations are required for both the fixed structural support (the turntable) and the concrete runway.

The work area shall be surveyed. Exclusion zones shall be laid out and flagged in accordance with the drawings. Silt fence will be installed as shown on Drawings 11FCD009 and 11FCD010.

Soil around the turntable foundation and the concrete runway foundation is excavated to an elevation of 582.5 feet The area east of Silo 1 is graded at an elevation of 578 feet to facilitate the initial assembly of the SWRS support structure. The area between the silos and the SWRS foundations is graded as shown on Drawing 11FCD003.

2.3 Phase 2A and Phase 2B–Operational Excavation

Phase 2A and 2B designates the excavation work on a periodic basis around Silo 1 and 2, respectively, concurrent with waste removal operations from each particular silo.

Phase 2A and 2B excavation activities will be performed by personnel from the Fernald Atomic Trades & Labor Council (FAT&LC). A FAT&LC crew of five members generally will be required. This crew consists of an excavator operator, front-end loader operator, health physics technician, and two laborers. This crew is needed for a minimum duration of 140 working days to perform both Phase 2A and 2B. This time does not include the setup time between the phases to move the superstructure and equipment.

Before starting excavation, a field survey crew will perform an elevation survey and layout in accordance with the drawings. This activity is similar to Phase 1 during which a series of flags and wooden stakes were used to establish a Hand Excavation Zone and an Equipment Exclusion Zone.

To avoid any additional loads on the silo walls, all excavating equipment must remain outside of the Equipment Exclusion Zone shown in Drawings 11FCD003 and 11FCD004. In addition, operators are required to demonstrate good control of equipment before excavating near the silos. The Hand Excavation Zone (an area extending 2 feet around Silos 1 and 2) is designated to further protect the silo walls from damage by excavation equipment.

Phase 2A starts with excavation of the berm soil around Silo 1 to an elevation of 586 feet as shown on Drawing 11FCD004. The cross section of Silo 1 is shown on Drawing 11FCD006. Excavation of the berm soil around Silo 1 is started only after the waste removal operation at Silo 1 begins. The expected duration for Phase 2A excavation is a nominal 70 working days per silo.

Phase 2B starts with excavation of berm soil around Silo 2 to an elevation of 586 feet as shown on Drawing 11FCD004. The cross section of Silo 2 is shown on Drawing 11FCD007. Excavation of the berm soil around Silo 2 will be started only after: (1) Silo 1 remediation is completed, (2) the bridge structure is moved on top of Silo 2, (3) all support facilities are readied for Silo 2 remediation operations, and (4) the waste removal operation at Silo 2 begins. The expected duration for Phase 2B excavation is a nominal 70 working days per silo.

Fluor Fernald allows a maximum height differential of 10 feet between the top of the berm elevation and the waste level in the silos. This maximum allowable height differential was established because of the deteriorating structural condition of the silos; the differential is intended to limit external and internal stresses on the silo walls.

At times during excavation, the equipment cab is located below the top of the waste elevation in the silo. During these times, the soil remaining in place will provide shielding to the equipment operator. It is estimated that a berm height of 4 feet higher than the top of the silo waste level will provide adequate protection from radiation. Therefore, the berm excavation and silo waste removal activities are coordinated to maintain the berm soil at a level 5 feet ± 1 foot higher than the waste level in the silos. ALARA protection of workers is verified continuously by monitoring equipment.

To maintain the berm soil at a level of 5 feet ± 1 foot higher than the waste levels in the silos, the excavated soil level and the silo waste level is recorded daily in a log. The daily log is reviewed by the site superintendent and field engineer to determine approximate height of berm to be removed (if any) the next morning. Berm excavation activity may not be started each day without prior approval from the Field Engineer. On the basis of the projected production rate of the waste removal process, an average volume of 50 cubic yards of berm soil will be removed each day during silo remediation.

Once a portion of berm is removed using equipment, the remaining material within the Hand Excavation Zone will be assisted to cave in/fall away from the silo walls using a hand held tool attached to a long pole to meet ALARA requirements.

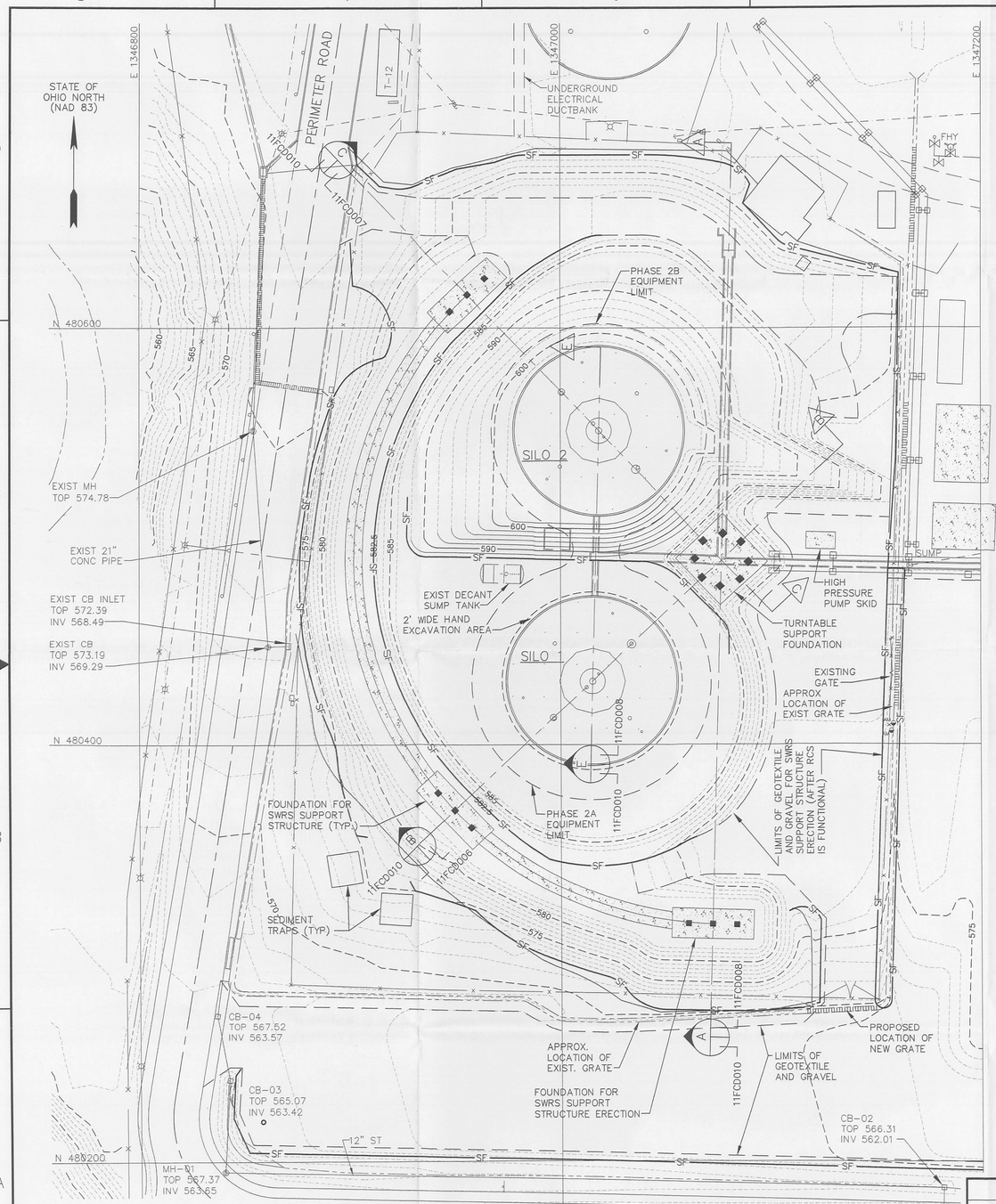
In all areas except between the two silos, the edge of the excavator, loader, and dump truck is kept outside the Equipment Exclusion Zone. Directly between the two silos, it is not possible to maintain the Equipment Exclusion Zone. Therefore, a Gradall is used to excavate the berm soil until it is safe to use the excavator. Use of small equipment generates additional load on the wall. However, this equipment is selected such that combined load from (1) 6 feet of soil (maximum differential that Foster Wheeler maintains) and (2) the small equipment does not exceed the load from 10 feet of soil (maximum differential allowed by Fluor Fernald). The Equipment Exclusion Zone is based on the load line (a line drawn at 45° upward from the base of a silo that intersects Phase I berm elevations). As the excavation progresses, the Equipment Exclusion Zone can be reduced after approval from the Field Engineer.

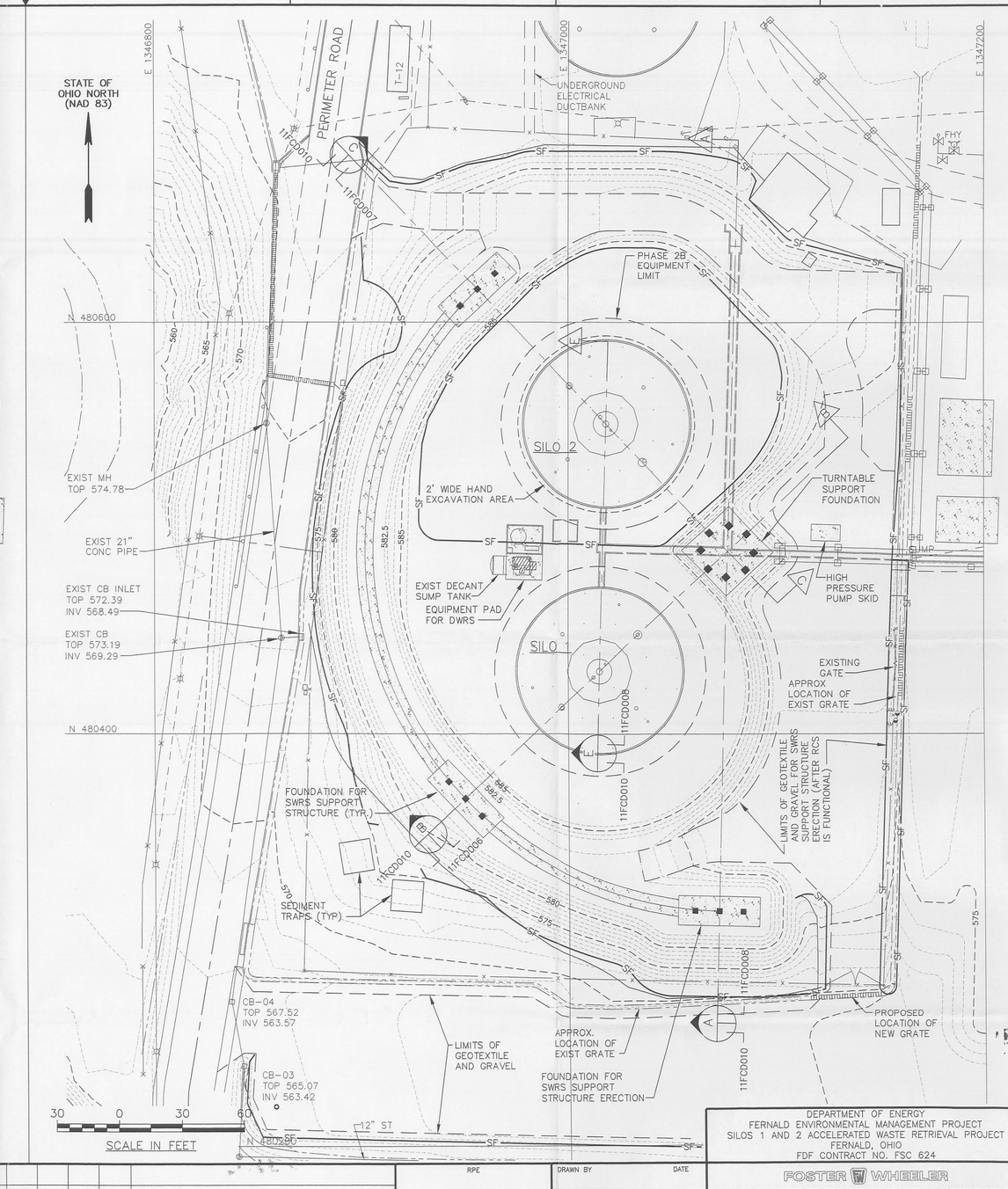
During excavation activities, the area is graded to avoid accumulation of surface water in low areas. Surface runoff is diverted to the existing surface water collection system. A small ditch is graded between the two silos to divert the runoff east and west.

3157

APPENDIX A:

BERM EXCAVATION DRAWINGS





NOTES:

1. SEE DRAWING 11FCD009 FOR NOTES.

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	6/21/00	WVD			SWRS GRADING – EPA REVIEW
B	1/7/00	WVD			ISSUED FOR OHIO EPA REVIEW
A		WVD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY	DATE
DESIGNED BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
EROSION CONTROL PLAN
PHASES 2A AND 2B

SIZE	SCALE:	DWG. NO.	REV
D	1"=30'	11FCD010	C

FILENAME: 11FCD010.DWG

3157

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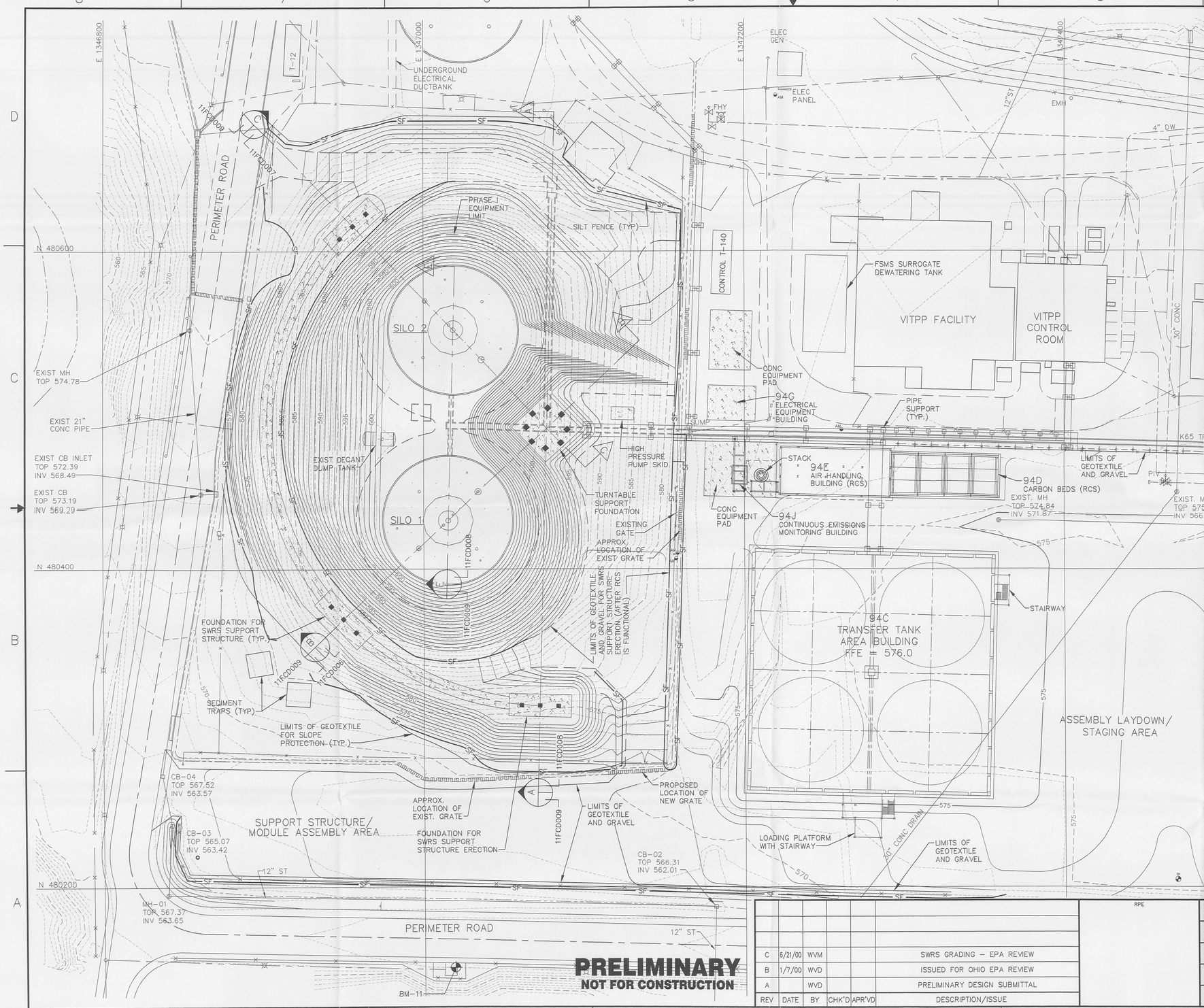

NOTES:

1. SEE DRAWING 05FCD011 FOR GENERAL NOTES AND LEGEND. HOLD
2. SEE DRAWING 66FCD002 FOR STORM WATER SYSTEM DRAINAGE PLAN.
4. SEE DRAWING 66FCD007 FOR STORM WATER SYSTEM PROFILES.
5. CONTRACTOR WILL BE RESPONSIBLE FOR LOCATING EXISTING UTILITIES BEFORE BEGINNING EXCAVATION.
6. ALL EROSION CONTROL MEASURES WILL BE INSTALLED AT THE BEGINNING OF EXCAVATION AND MAINTAINED FOR THE DURATION OF THE PROJECT.
7. AREAS DISTURBED BY EXCAVATION ACTIVITIES ARE TO BE SEEDED AND MULCHED AS SOON AS PRACTICAL, REFER TO SPECIFICATION SECTION 02924.
8. REFER TO SPECIFICATION SECTION 02300 FOR EARTHWORK.
9. BM-11 LOCATION: N 480,149.10 E 1,347,018.61 ELEV. 569.14
10. SEPARATION FABRIC SHALL BE MIRAFI 180 N OR EQUIVALENT.
11. REFER TO SPECIFICATION SECTION 02722 FOR AGGREGATE AND/OR GRADED, CRUSHED AGGREGATE BASE COURSE.
12. REFER TO SPECIFICATION SECTION 02630 FOR STORM DRAINAGE.
13. CONTRACTOR RESPONSIBLE FOR LOCATING EXISTING FEATURES WITH SURVEY TIE-INS.
14. EXISTING STANDPIPE AT DECANT SUMP TANK TO BE PROTECTED DURING ALL PHASES OF EXCAVATION WITH A 2' HAND EXCAVATION AREA AROUND PIPE.

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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A		WVD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY WVD	DATE
DESIGNED BY KEO	DATE
CHECKED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

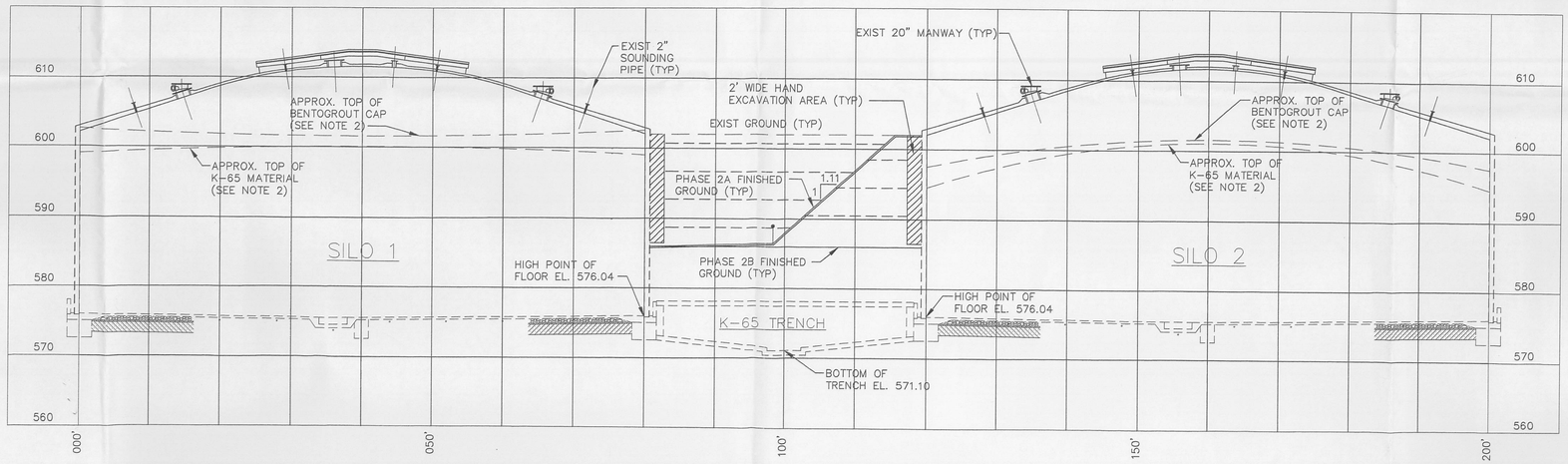
TITLE
SILO WASTE RETRIEVAL SYSTEM
EROSION CONTROL PLAN
PHASE 1

SIZE	SCALE:	DWG. NO.	REV
D	1"=30'	11FCD009	C

FILENAME: 11FCD009.DWG

3157

3157



SECTION

SCALE: 1"=10'

E

11FCD003
11FCD004
11FCD009
11FCD010

11FCD008

NOTES:

1. SILO 1 CONTAINS APPROXIMATELY 115,900 CUBIC FEET OF MATERIAL (INCLUDING RESIDUE AND DISCRETE OBJECTS) AND APPROXIMATELY 12,600 CUBIC FEET OF BENTOGROUT.
2. SILO 2 CONTAINS APPROXIMATELY 100,400 CUBIC FEET OF MATERIAL (INCLUDING RESIDUE AND DISCRETE OBJECTS) AND APPROXIMATELY 11,100 CUBIC FEET OF BENTOGROUT.
3. APPROXIMATE LOCATION OF BENTOGROUT CAP AND K-65 MATERIAL COMES FROM SECTION 2.5.1 OF THE TECHNICAL REQUIREMENTS DOCUMENT.
4. EXCAVATION AROUND SILOS DURING PHASE 2A AND PHASE 2B WILL BE COORDINATED WITH THE HEIGHT OF K-65 MATERIAL WITHIN EACH SILO SUCH THAT THE HEIGHT DIFFERENTIAL ON BOTH SIDES OF SILO WALL DOES NOT EXCEED 10 FEET UNTIL FINISHED GROUND ELEV OF 586 IS REACHED.
5. SEE SPECIFICATION SECTION 02375 FOR GEOTEXTILE. REMOVE PORTIONS OF GEOTEXTILE TO EXCAVATE EACH LIFT AND REATTACH AFTER EXCAVATION WORK IS FINISHED.

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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A		WVD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY DATE
DESIGNED BY DATE
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

3157

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

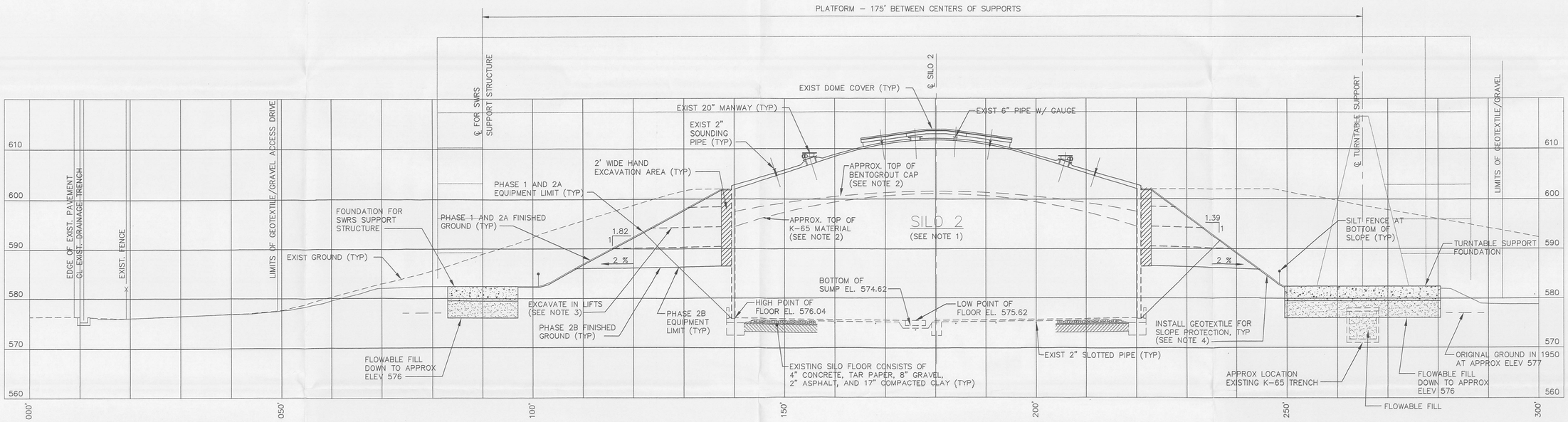
FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
CROSS SECTIONS
SHEET 4

SIZE	SCALE:	DWG. NO.	REV
D	1"=10'	11FCD008	C

FILENAME: 11FCD008.DWG

3157



SECTION

SCALE: 1"=10'

C

11FCD003
11FCD004
11FCD009
11FCD010

11FCD007

LETTER OR NUMBER OF SECTION OR DETAIL

DRAWING ON WHICH SECTION OR DETAIL IS TAKEN

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

3157

NOTES:

1. SILO 2 CONTAINS APPROXIMATELY 100,400 CUBIC FEET OF MATERIAL (INCLUDING RESIDUE AND DISCRETE OBJECTS) AND APPROXIMATELY 11,100 CUBIC FEET OF BENTOGROUT.
2. APPROXIMATE LOCATION OF BENTOGROUT CAP AND K-65 MATERIAL COMES FROM SECTION 2.5.1 OF THE TECHNICAL REQUIREMENTS DOCUMENT.
3. EXCAVATION AROUND SILOS DURING PHASE 2A AND PHASE 2B WILL BE COORDINATED WITH THE HEIGHT OF K-65 MATERIAL WITHIN EACH SILO SUCH THAT THE HEIGHT DIFFERENTIAL ON BOTH SIDES OF SILO WALL DOES NOT EXCEED 10 FEET UNTIL FINISHED GROUND ELEV OF 586 IS REACHED.
4. SEE SPECIFICATION SECTION 02375 FOR GEOTEXTILE. REMOVE PORTIONS OF GEOTEXTILE TO EXCAVATE EACH LIFT AND REATTACH AFTER EXCAVATION WORK IS FINISHED.

PRELIMINARY
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C	6/21/00	WVM			SWRS GRADING – EPA REVIEW
B	1/7/00	WVD			ISSUED FOR OHIO EPA REVIEW
A		WVD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY WVD	DATE
DESIGNED BY KEO	DATE
CHECKED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

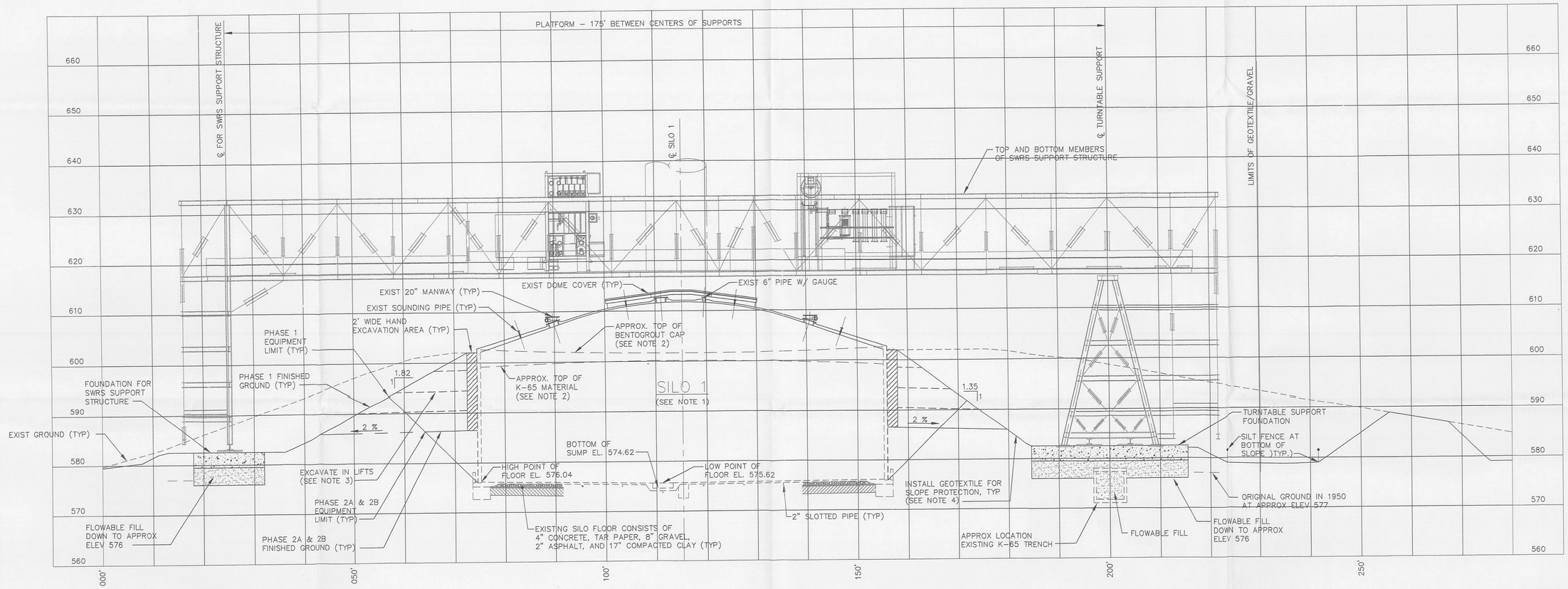
FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
CROSS SECTIONS
SHEET 3

SIZE	SCALE:	DWG. NO.	REV
D	1"=10'	11FCD007	C

FILENAME: 11FCD007.DWG

3157



SECTION B

SCALE: 1"=10'

11FCD003
11FCD004
11FCD009
11FCD010

11FCD006

NOTES:

1. SILO 1 CONTAINS APPROXIMATELY 115,900 CUBIC FEET OF MATERIAL (INCLUDING RESIDUE AND DISCRETE OBJECTS) AND APPROXIMATELY 12,600 CUBIC FEET OF BENTOGROUT.
2. APPROXIMATE LOCATION OF BENTOGROUT CAP AND K-65 MATERIAL COMES FROM SECTION 2.5.1 OF THE TECHNICAL REQUIREMENTS DOCUMENT.
3. EXCAVATION AROUND SILOS DURING PHASE 2A AND PHASE 2B WILL BE COORDINATED WITH THE HEIGHT OF K-65 MATERIAL WITHIN EACH SILO SUCH THAT THE HEIGHT DIFFERENTIAL ON BOTH SIDES OF SILO WALL DOES NOT EXCEED 10 FEET UNTIL FINISHED GROUND ELEV OF 586 IS REACHED.
4. SEE SPECIFICATION SECTION 02375 FOR GEOTEXTILE. REMOVE PORTIONS OF GEOTEXTILE TO EXCAVATE EACH LIFT AND REATTACH AFTER EXCAVATION WORK IS FINISHED.

LETTER OR NUMBER OF SECTION OR DETAIL

DRAWING ON WHICH SECTION OR DETAIL IS TAKEN

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	6/21/00	WVM			SWRS GRADING – EPA REVIEW
B	1/7/00	WVD			ISSUED FOR OHIO EPA REVIEW
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RPE

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APPROVED BY DATE

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SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
CROSS SECTIONS
SHEET 2

SIZE	SCALE:	DWG. NO.	REV
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FILENAME: 11FCD006.DWG

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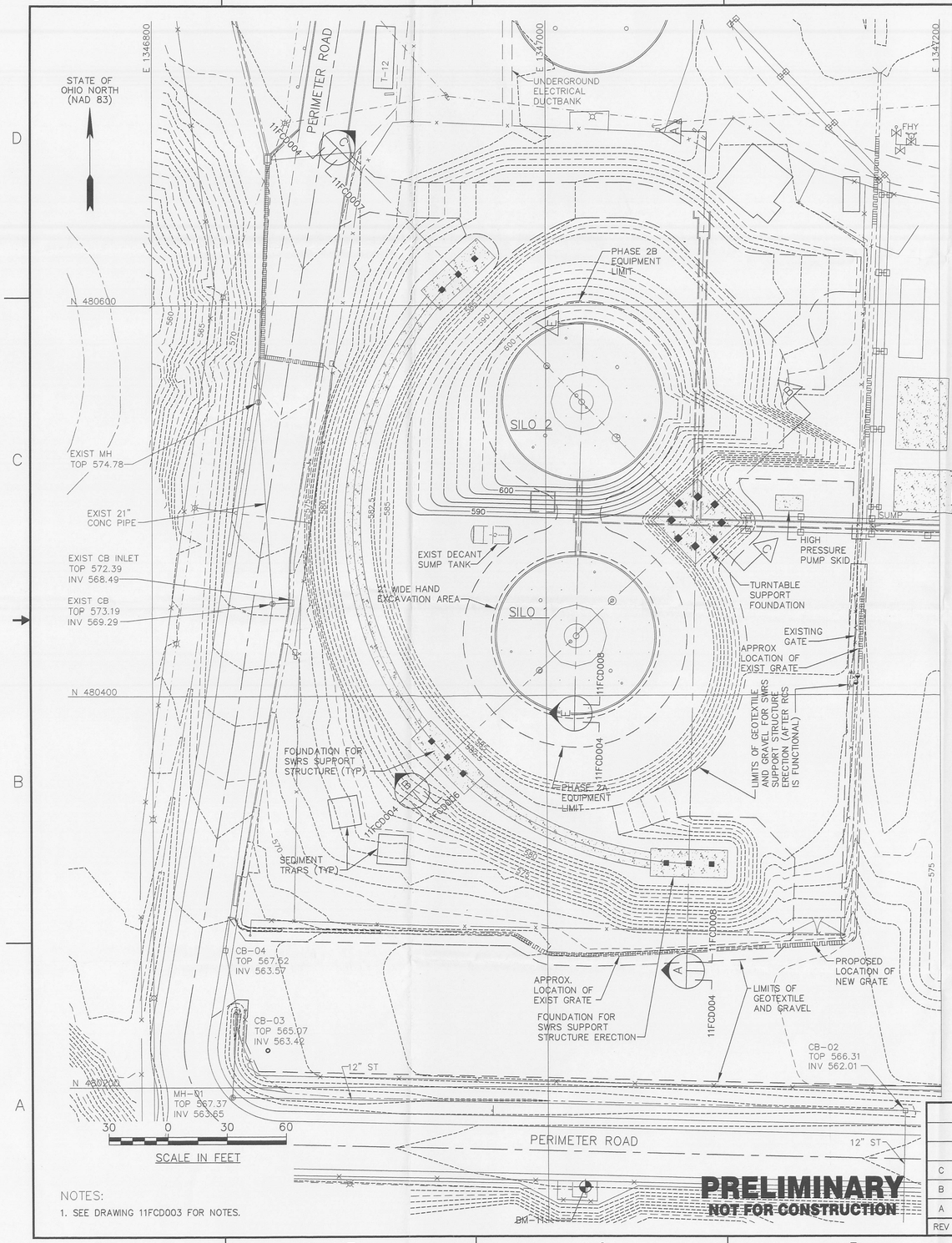

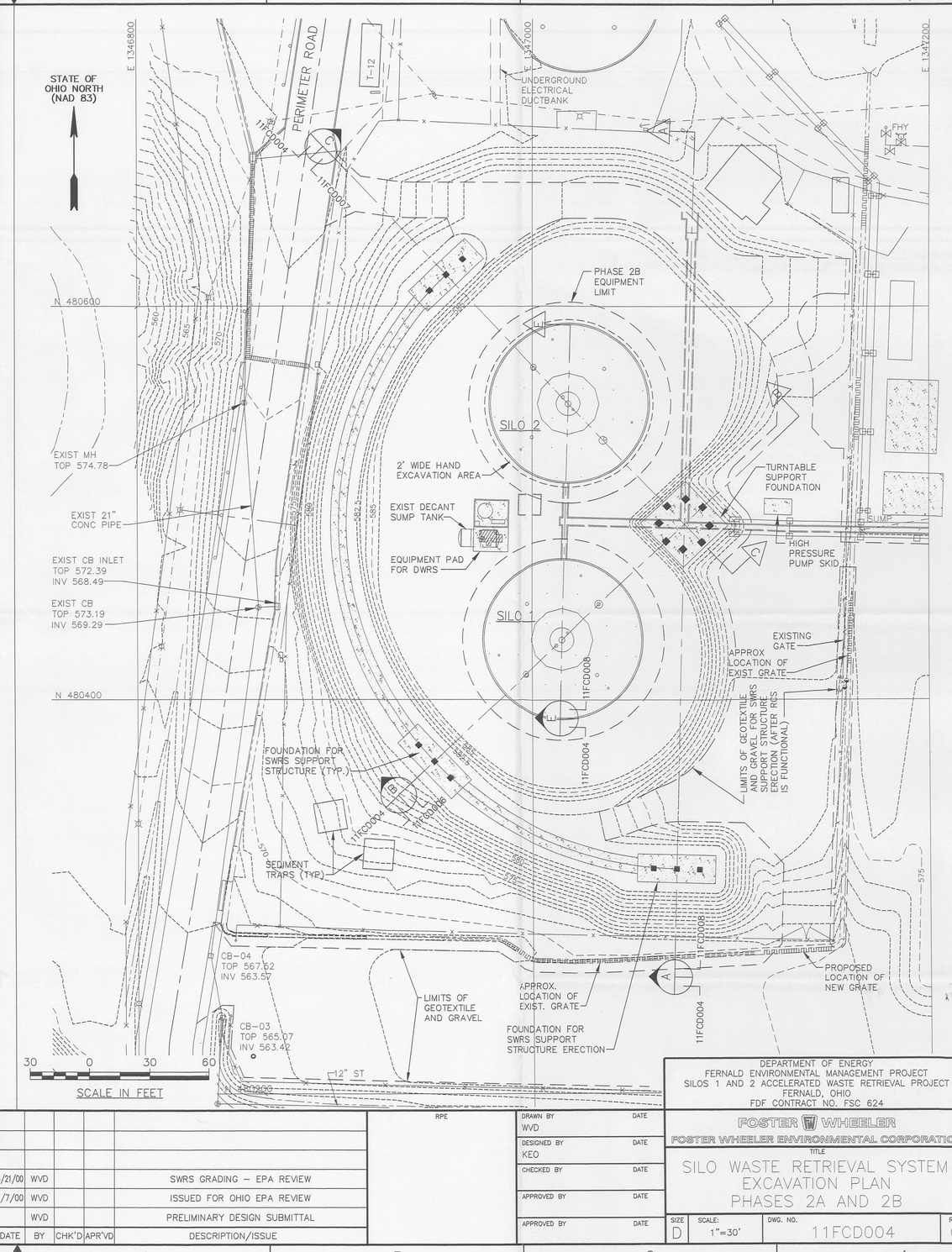

NOTES:

1. SEE DRAWING 11FCD003 FOR NOTES.

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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RPE

DRAWN BY WVD	DATE
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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
EXCAVATION PLAN
PHASES 2A AND 2B

SIZE	SCALE:	DWG. NO.	REV
D	1"=30'	11FCD004	C

FILENAME: 11FCD004.DWG

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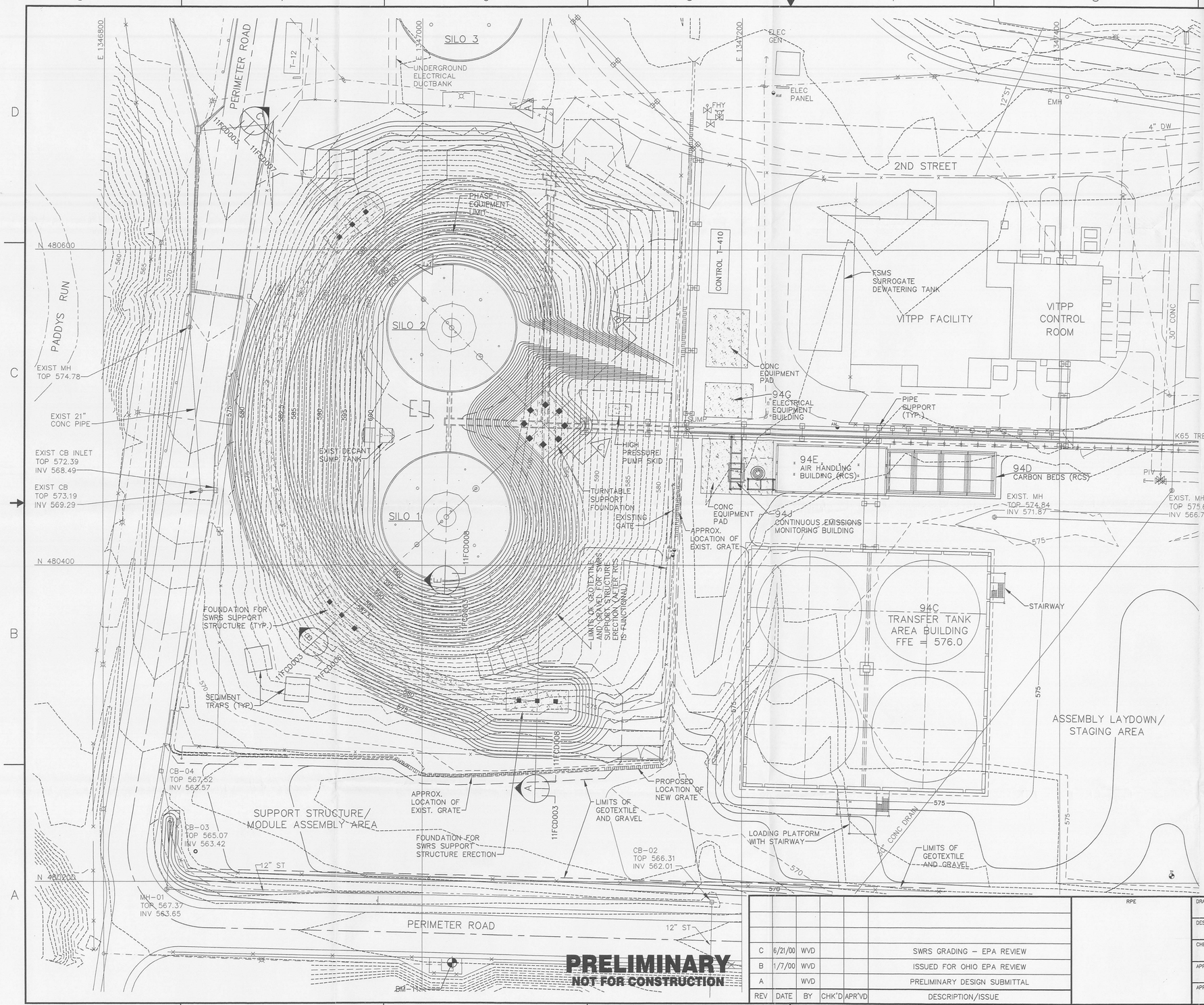

NOTES:

HOLD

1. SEE DRAWING 05FCD011 FOR GENERAL NOTES AND LEGEND.
2. SEE DRAWING 66FCD002 FOR STORM WATER SYSTEM DRAINAGE PLAN.
4. SEE DRAWING 66FCD007 FOR STORM WATER SYSTEM PROFILES.
5. CONTRACTOR WILL BE RESPONSIBLE FOR LOCATING EXISTING UTILITIES BEFORE BEGINNING EXCAVATION.
6. ALL EROSION CONTROL MEASURES WILL BE INSTALLED AT THE BEGINNING OF EXCAVATION AND MAINTAINED FOR THE DURATION OF THE PROJECT.
7. AREAS DISTURBED BY EXCAVATION ACTIVITIES ARE TO BE SEEDED AND MULCHED AS SOON AS PRACTICAL, REFER TO SPECIFICATION SECTION 02924.
8. REFER TO SPECIFICATION SECTION 02300 FOR EARTHWORK.
9. BM-11 LOCATION: N 480,149.10 E 1,347,018.61 ELEV. 569.14
10. SEPARATION FABRIC SHALL BE MIRAFI 180 N OR EQUIVALENT.
11. REFER TO SPECIFICATION SECTION 02722 FOR AGGREGATE AND/OR GRADED, CRUSHED AGGREGATE BASE COURSE.
12. REFER TO SPECIFICATION SECTION 02630 FOR STORM DRAINAGE.
13. CONTRACTOR RESPONSIBLE FOR LOCATING EXISTING FEATURES WITH SURVEY TIE-INS.
14. EXISTING STANDPIPE AT DECANT SUMP TANK TO BE PROTECTED DURING ALL PHASES OF EXCAVATION WITH A 2' HAND EXCAVATION AREA AROUND PIPE.

STATE OF OHIO NORTH (NAD 83)

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

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SCALE IN FEET

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PRELIMINARY
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FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
EXCAVATION PLAN
PHASE 1

SIZE	SCALE:	DWG. NO.	REV
D	1"=30'	11FCD003	C

FILENAME: 11FCD003.DWG

XREF DRAWINGS: 30-EXIST.DWG
30-PROP.DWG

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OPERATIONAL ENVIRONMENTAL CONTROL PLAN

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

REVISION 1

JUNE 2000

3157

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 METHODS AND CONTROLS 1

2.1 Air Emissions Control 1
2.2 Dust Control 5
2.3 Wastewater Control 5
2.4 Stormwater Control 6
2.4.1 Employee Training 7
2.4.2 Spill Prevention Control and Countermeasures 8
2.4.3 Inspections and Recordkeeping 9

2.5 Erosion Control 10
2.6 Secondary Waste Management 11
2.7 Decant Sump Tank Waste Water Management 11

Appendix 5.1 – Environmental ALARA Report
Appendix 5.2 – Waste Handling Work Plan
Appendix 5.3 – ARAR Compliance Matrix

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3157

ACRONYM LIST

ALARA	as low as reasonably achievable
ARARs	Applicable or Relevant and Appropriate Requirements
AWR	Accelerated Waste Retrieval
AWWT	Advanced Wastewater Treatment
BAT	best available technology
BMPs	best management practices
CCA	Clean Air Act
CCB	Change Control Board
CCWW	City of Cincinnati Water Works
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	certified for construction
CFR	Code of Federal Regulations
DCGs	Derived Concentration Guides
DOE	U.S. Department of Energy
ECP	Environmental Control Plan
ED	Engineering Design
EDE	effective dose equivalent
EP	Environmental Protection
EPA	Environmental Protection Agency
EW	Environmental Restoration/Waste Management
FDF	Fluor Daniel Fernald
FEMP	Fernald Environmental Management Project
FRD	Functional Required Documents
HEPA	high efficiency particulate air
HVAC	Heating, Ventilating, and Air Conditioning
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NWP	Nationwide Permit
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OSHA	Occupational Safety and Health Administration
PTI	Permit to Install
RCRA	Resource Conservation and Recovery Act
RCS	Radon Control System
SDWA	Safe Drinking Water Act
SOPs	Standard Operating Procedures
SWMUs	Solid Waste Management Units
SWPPP	Stormwater Pollution Prevention Plan
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TRD	Technical Requirements Document
TSD	treatment, storage or disposal
TSS	Total Suspended Solids
TTA	Transfer Tank Area
USACE	U.S. Army Corps of Engineers
WAC	waste acceptance criteria

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1.0 INTRODUCTION

This Environmental Control Plan (ECP) describes the methods and controls that are to be incorporated into the design and operation of the Accelerated Waste Retrieval (AWR) Project to minimize the impacts of operation activities on the environment. These methods and controls, as described in Section 2.0, are intended to minimize the environmental impacts of air emissions, dust, wastewater, stormwater, erosion, and secondary waste generation resulting from AWR Project activities at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. Controls implemented to minimize the environmental impact of construction activities were documented in the Pre-operational Environmental Control Plan, submitted and approved as part of the AWR Project Site Preparation Package in May 2000.

AWR Project activities are to be performed in compliance with applicable environmental laws and regulations. These laws and regulations, at both the federal and state level, have been incorporated into Applicable or Relative and Appropriate Requirements (ARARs) for the AWR Project. This ECP describes the design and operational control strategies used for the AWR Project to ensure compliance with these ARARs, as well as the FEMP functional area requirements for environmental protection (EP) and environmental restoration/waste management (EW). Compliance with ARARs is summarized in Section 3.0, and compliance with EP and EW functional area requirements is summarized in Section 4.0.

Overall FEMP site environmental monitoring is performed by Fluor Daniel Fernald (FDF). Project-specific enhancements to the site-wide monitoring programs to address air, direct radiation, and wastewater impacts during the AWR and Silo 3 Projects are documented in the **Silos Projects Environmental Monitoring Plan, document 400000-PL-0010.** The Silos Projects Environmental Monitoring Plan is presented in Appendix D of the Remedial design Package.

2.0 METHODS AND CONTROLS

This section describes the various methods and controls to be incorporated into the design, construction, and operation of the AWR Project to minimize the impacts of operation activities on the environment. These impacts are mitigated through the use of controls associated with air emissions, dust, wastewater, stormwater, erosion, and secondary waste generation.

2.1 Air Emissions Control

Air emissions are controlled for the AWR Project by the Radon Control System Radon Control System (RCS). Emissions from the Silos 1 and 2 headspace, the Silos Waste Retrieval System, and the Transfer Tank Area (TTA) are collected and ducted to the RCS. The RCS system is designed to operate at a negative pressure. Air emissions from AWR Project activities are evaluated for four distinct phases:

Phase 1: Silos 1 and 2 Headspace Reduction
Phase 2: Silo 1 Waste Retrieval
Phase 2B: Silo 2 Waste Retrieval
Phase 2C: TTA Ventilation

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Phase 1 operation of the RCS will be established prior to accomplishing initial penetration of the Silo dome manways. During penetration and modification of the manways, the RCS will be operated to maintain negative pressure in the headspace and assure airflow into the silo through the manways. The ***Silo Penetration Plan,*** included as Appendix E of the AWR Project RD Package, describes the methods to be employed to accomplish initial access through the domes of Silos 1 and 2 in order to complete connections to the RCS and Waste Retrieval Systems.

During all four of these phases, airflow in the air emission control system will be closely managed to minimize the release of air emissions to the environment. To the extent practical, the system will be operated in a 'recycle' mode where all or most of the air is withdrawn from the Silo or TTA headspace, circulated through the RCS, and discharged back into the Silo or TTA. The airflow discharged to the environment through the exhaust stack will be minimized to the amount necessary to maintain negative pressure and to provide effective operation and control of the system.

The RCS is also designed to provide control and monitoring of emissions from the Silos 1 and 2 Full-scale Stabilization Facility. The impact of emissions from operation of the Silos 1 and 2 Full-scale Stabilization Facility will be addressed in detail in the Remedial Design documentation prepared based upon the specific design for that facility.

The air emission control system for the AWR Project is depicted on Exhibit 2-1. Flow rates and mass balance data for each of the phases of RCS operation are provided on Drawings 20FMD001 and 20FMD002.

The design of the air emission control system and associated retrieval systems for the AWR Project will result in minimal emissions of particulate radionuclides. Recirculated supply air to the silos is returned at a rate and pressure that will prevent ducting or particulate agitation during Phase 1 RCS operation. The retention time for the supply air into the silo headspace is approximately 90 minutes at the beginning of Phase 1 and becomes longer during subsequent phases as waste retrieval progresses. During Phase 2 operations, air is pulled into the silos through filters on the three enclosures on the bridge. This design will ensure that particulate infiltration into the system is minimized. In addition, the moisture level if the silo material during sluicing operations will minimize particulate generation.

Despite the minimal level of radionuclide particulate emissions, the RCS design includes continuous stack monitoring consistent with NESHAP Subpart H and Best Available Technology (BAT) control equipment for radionuclide particulate sources. The control of particulates that become entrained in the silo air stream that is exhausted to the RCS is accomplished by using 95% ASHRAE roughing filters (FLT-20-001A and FLT-20-001B) upstream of the desiccant dryer skids (DDS-20-001A and DDS-20-001B). These filters will remove most of the particulates from the silos or from the radon decay to its daughters during the transit of ventilation air from the silos. These filters also protect the desiccant skids by preventing obstruction of the cooling coil and desiccant wheel of the operating skid. Ultimately, the roughing filters and desiccant dryers prevent passage of particulates into the carbon adsorption beds. While the carbon adsorption beds are used to hold up the radon and allow it to decay, they also acts as media filters by trapping the particulate daughters associated with radon decay. Directly downstream of the carbon adsorption beds, a set of HEPA filters (FLT-20-002A and FLT-20-002B) are used to remove particulate that pass through or are released from the adsorption beds prior to stack discharge.

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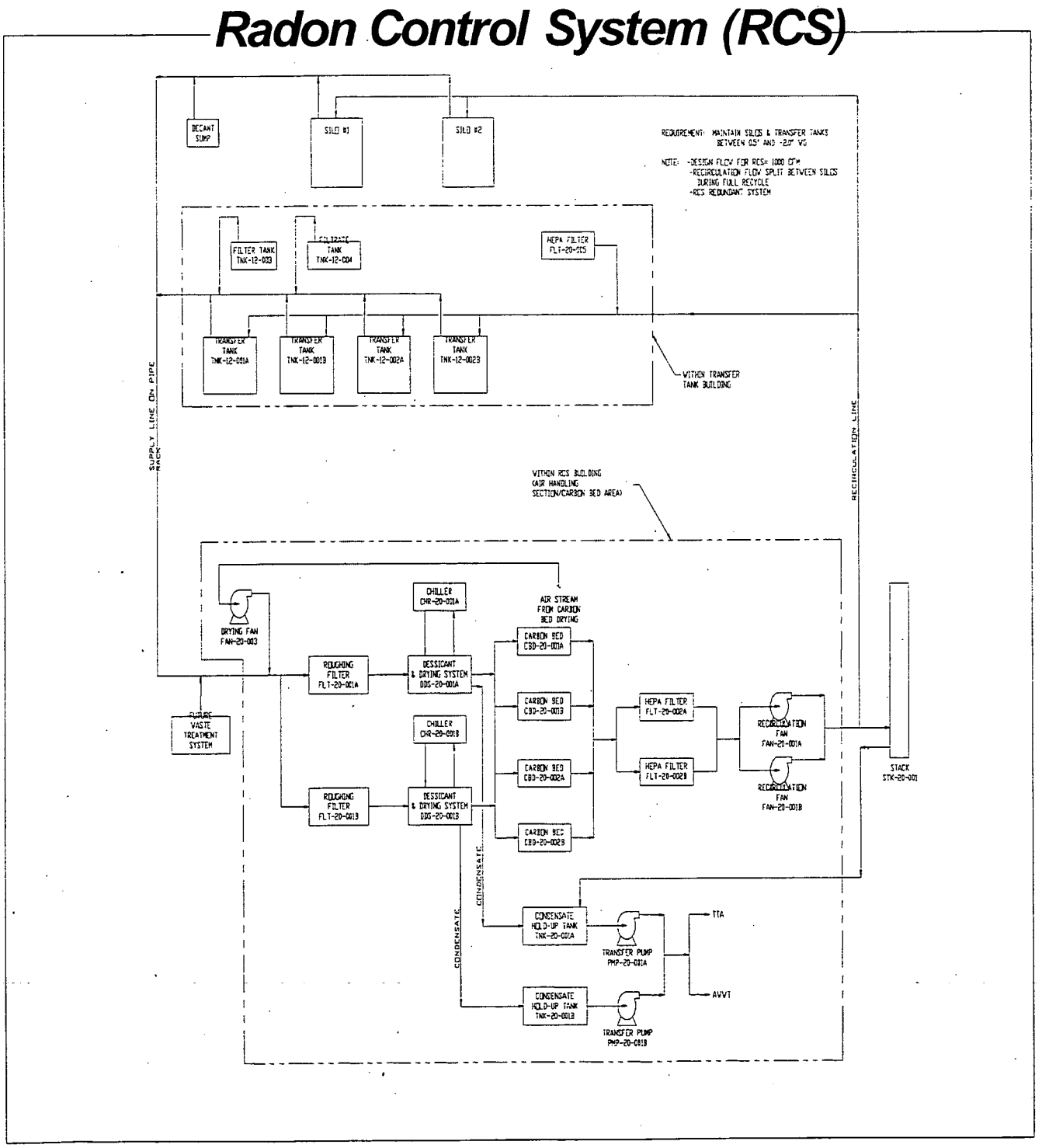
Exhibit 2-1 – RCS schematic



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The stack receives the treated RCS ventilation stream from sources associated with the AWR Project and from the building exhaust for the RCS Building. The exhaust air from the RCS Building is also filtered through a set of HEPA filters (FLT-77-002A and FLT-77-002B) prior to discharge. Also, the supply air to the RCS Building is filtered to remove particulates. The air stream exiting the stack is continuously monitored and alarmed for radiological particulate discharges. Upon an out-of-parameter reading for radiological particulates, an alarm will be initiated and the RCS will be placed in a recirculation mode or will be shutdown.

Detailed analysis of radon emissions, including modeling of offsite impact, from material handling and process equipment is descried in the Environmental ALARA Report for the AWR Project (Document No. 40710-624-P622-10B), which is included in Section 5.1. These data are summarized below.

Exhibit 2-2: Radon Emissions from the RCS Exhaust Stack

AWR Project Phase	Stack Exhaust Radon (pCi/l)	On-site Weekly Average Radon (pCi/l)	Fence-line Annual Average Radon (pCi/l)
1. Headspace Reduction	0.14	9.56E-07	2.85E-07
2A. Silo 1 Retrieval	90	6.13E-04	1.83E-04
2B. Silo 2 Retrieval	72	5.61E-04	1.67E-04
2C. TTA Ventilation	1	8.17E-06	2.44E-06

Continuous Isokinetic sampling of the stack exhaust for particulate radionuclides shall be performed in compliance with Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H, and DOE Order 5400.5, Section IV.6.B. A stack monitor provided in the horizontal run of duct is located between the high efficiency particulate air (HEPA) filters and the stack. In addition, the stack exhaust is continuously monitored for radon. The HEPA filters are designed to remove 99.97% of particles with an aerodynamic diameter of 0.3 microns. A sufficient length of straight duct is provided downstream of the HEPA filters to ensure that the distribution of any remaining particulates in the stack is uniform. The monitor consists of a probe assembly and a sampling and monitoring rack. The probe assembly fits into the stack and has the capability for measuring stack flow and for withdrawal of an isokinetic sample. The sample rack includes redundant sampling pumps with automatic switch-over, a flow controller that matches the flow rate in the sample nozzle with that in the duct, and a coincidence counter for analyzing the radiation from the sample collected on a filter paper. The air stream flows through the filter paper is directed through a continuous radon monitor that measures the concentration of radon in the stack effluent. Analytical instruments will be provided for separately distinguishing radon daughters from other alpha and beta emitting radionuclides.

Monitoring data is collected and analyzed by a local computer, then transferred to the AWR Control Room for display and recordkeeping. Alarm circuits are available to alert the AWR Control Room operator if an out-of-specification condition exists in the stack. The radon monitor has an alarm setpoint established to maintain radon as low as reasonably achievable (ALARA). Operating controls for the entire system are included in the AWR Control Room. These controls allow for the shutdown or start-up of any piece of equipment in the RCS. These controls are presented in greater detail in the ***Process Control Plan***, Section 2.2 of this RD Package.

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2.2 Dust Control

The spread of fugitive dust is controlled during the construction and operation of the AWR Project facilities in compliance with applicable regulations and Best Available Technology (BAT) requirements for control of fugitive dust emissions. Site-specific BAT control measures for fugitive dust control at the FEMP have been developed by DOE and approved by OEPA. These control measures are documented in RM-0047, "FEMP Fugitive Dust Requirements."

Implementation of fugitive dust control measures for the AWR Project, consistent with RM-0047, is described in detail in the "Fugitive Dust Control Plan for the AWR Project" (Document No. 40710624-P6455-01) and in the Pre-operational Environmental control Plan, which was submitted and approved as part of the Site Preparation Package in May 2000. The "Fugitive Dust Control Plan for the AWR Project" is attached as Appendix B of this Environmental Control Plan. Fugitive Dust will be controlled during berm excavation, facility construction, and operation activities through implementation of these same measures.

In addition, AWR Project field activities should be continuously observed by project personnel for visible emissions. The number of pieces or type of dust suppression equipment in operation controlling visible dust emission in a designated area will not preclude stopping project field activities in that area. Personnel should be on-call during non-work periods seven days per week, including holidays, to respond to the generation of visible dust during off-hours.

Mechanical dust generating field activities in an observed area shall cease immediately if a fugitive dust standard or site-specific limit is exceeded for that observed area. An increase in BAT dust controls and/or work practices needs to be implemented to bring the fugitive dust emissions to, at a minimum, below the standard or limit during dust generating activities (including wind erosion).

2.3 Wastewater Control

Water shall be added to the silo waste in order to transfer the waste to the Transfer Tank Area (TTA). A settle decant process allows for the reuse of water used to transfer the waste to the TTA storage tanks and minimizes any wastewater discharge to the FEMP Advanced Wastewater Treatment (AWWT). Water used in decontaminating the waste retrieval equipment drains to the waste retrieval system and is sent to the TTA storage tanks and processed containment/control features to preclude environmental releases.

In addition, liquids condensed from the gas steam generated at the RCS will be transferred to shielded hold-up tanks, held up for up to 40 days for radon decay, and returned to the waste retrieval/transfer system for reuse or pumped into the AWWT. Water required to be pumped to the AWWT is first sampled, analyzed, and radiologically surveyed to meet the waste acceptance criteria (WAC) of the AWWT (see Exhibit 2-3) prior to pumping. This characterization ensures that the wastewater does not exceed the parameters specified in Exhibit 2-3.

As a contingency, if the wastewater characterization indicates that the wastewater stream does not meet the AWWT WAC, then pretreatment of the stream using ultra-filtration is performed. Water is then resampled to confirm that it meets the WAC. If the wastewater still exceeds the WAC, then additional treatment using ultra-filtration and/or ion exchange processing is performed. The wastewater may also be recirculated through the TTA system. The water is then resampled to confirm that it meets the WAC.

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Exhibit 2-3: Wastewater Acceptance Criteria for AWR Liquid Discharge to AWWT

METALS PARAMETER	DISCHARGE LIMIT (kg/day)	DISCHARGE LIMIT (lb/day)	RADIONUCLIDE PARAMETER	DISCHARGE LIMIT (pCi/L)
Arsenic (As)	0.14	0.3	Actinium-227 (^{227}Ac)	10
Barium (Ba)	2.7	6.0	Lead-210 (^{210}Pb)	30
Cadmium (Cd)	0.006	0.013	Polonium-210 (^{210}Po)	80
Chromium (Cr)	0.14	0.3	Protactinium-231 (^{231}Pa)	10
Lead (Pb)	0.03	0.07	Radium-226 (^{226}Ra)	100
Mercury (Hg)	0	0	Radium-228 (^{228}Ra)	100
Selenium (Se)	0.03	0.06	Thorium-228 (^{228}Th)	400
Silver (Ag)	0.0014	0.003	Thorium-230 (^{230}Th)	300
Iron (Fe)	0.3	0.06	Thorium 232 (^{232}Th)	5 ppm
			Uranium-234 (^{234}U)	
			Uranium-234/236 ($^{235/236}$U)	5 ppm
			Uranium-238 (^{238}U)	
MAXIMUM FLOW				5 gpm (7,200 gpd)
TOTAL SUSPENDED SOLIDS (TSS)				1,000 ppm

In addition to the above criteria, no listed or characteristic hazardous waste, nor wastewater containing concentrations of RCRA metals (e.g., lead) above the RCRA toxicity characteristic (TC) limits, may be discharged to the AWWT without appropriate pretreatment.

2.4 Stormwater Control

The existing FEMP Stormwater Pollution Prevention Plan (PL-3083, Rev. 0) defines current requirements for management of stormwater, consistent with the FEMP NPDES Permit (permit No. 1IO0004*FD) within the project site. The AWR Project area is contained within two drainage watersheds. The following paragraphs describe the existing and proposed stormwater control measures at the AWR Project site to ensure the segregation and proper management of uncontaminated and contaminated stormwater. These control measures are outlined in greater detail in the Stormwater Drainage Plan (Document No. 40710-624-P622-17).

Existing—An existing perimeter channel collects runoff from the Silo domes and the surrounding berms. The perimeter channel consists of a combination of small rectangular concrete channels, concrete curb, grates, and pipes. The perimeter channel drains to the Waste Pit Area Runoff Control Sump which was installed as part of CERCLA Removal Action 2 and is located 1,000 feet west-northwest of the silos. The sump has a capacity of 350,000 gallons. This sump also receives drainage from the waste pits to the north. A 12-in. main leads from the sump into the Bio-Surge Lagoon, which discharges to the Advanced Wastewater Treatment (AWWT) facility.

Areas not surrounded by the perimeter channel ultimately drain to the Pilot Plant Drainage Ditch (PPDD), which runs south of the project area and enters Paddy's Run at NPDES outfall STRM 4005, and drains a total of approximately 78 acres. As illustrated on Drawing No. 66FCD001, the majority of this area reaches the PPDD via an existing storm water basin at the southeast quadrant of the project area. A few culverts cross the southern perimeter road and discharge stormwater to the PPDD.

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Proposed—Control measures will be employed during implementation of AWR Project activities to assure that impacts to natural resources in the Paddy's Run corridor are minimized. As described in the subsequent sections of this Plan, excavation activities have been planned to minimize the area disturbed. No disturbance (excavation, removal of trees, etc.) is planned in areas immediately adjacent to Paddy's Run. Erosion and sediment control measures will be employed during excavation to prevent impacts from stormwater runoff. Finally, drainage patterns will be maintained to prevent impacts to Paddy's Run due to spills or releases during the operational phase of the AWR Project.

AWR Project activities will not change or move existing drainage divides. Erosion and siltation in the concrete channels surrounding Silos 1 and 2 will be prevented through erosion and sediment control measures identified in Section 2.5. The perimeter road functions as the outer limit of operations. Rainfall will not directly contract the TTA process area since it is equipped with a roof and gutter system. Therefore, contaminated stormwater from this area is not anticipated.

Stormwater drainage during and after AWR Project site preparation construction activities is illustrated on Drawing 66FCD001. Drainage from the Silo 1 and 2 domes and berms, and from the Silo 4 area, will continue to be collected by the existing trench system and discharged to the Waste Pit Area Runoff Control Sump (WPSRC). As detailed on drawing 66FCD002, silt fence and sediment traps will be utilized to prevent silt buildup in the trench system. The trench will be included in the erosion and sediment control inspections to provide additional assurance that it has not become obstructed. For the purpose of designing the drainage and stormwater controls for the AWR Project, the project area has been divided into eight drainage areas. These drainage areas are summarized below.

Drainage Area	Description	Outlet
1	Construction Trailer Area	Existing SE stormwater basin at 18" outlet
2	Laydown Area	Existing SE stormwater basin at CB-01
3	Assembly Area	Exiting SE stormwater basin at CB-01
4	TTA and RCS roof drains	Existing SE basin via 18" outlet
5	Area South of Silos 1 and 2	PPDD via CB-02
6	TTA control area	Basin at NE quadrant of project area
7	Silo 1 and 2 area	WPSRC sum via perimeter trench
8	Silo 4 area	WPSRC sump via existing drainage

These drainage areas, as well as the runoff coefficients and flows used to assure adequate capacity of the drainage system, are detailed in the Site preparation package for the AWR Project.

2.4.1 Employee Training

Construction personnel receive appropriate environmental and safety training on their job requirements. Environmental awareness is raised by issuing periodic bulletins concerning such topics as spill control. Supervisors are responsible for providing on-the-job training with respect to hazardous materials handling and company environmental policy. This training is documented and records are kept onsite.

3157

Work being performed on the AWR Project is required to comply with the environmental policies of the FEMP site. In addition, site personnel are to perform the work as specified in the applicable certified for construction (CFC) drawings and construction specifications.

Earthwork operations and general construction personnel are subject to normal industrial hazards, and therefore, appropriate precautions are to be taken. Employees are to be trained to follow appropriate Occupational Safety and Health Administration (OSHA) standards with regard to fall protection and trench safety. In addition, hazards involved in working around heavy equipment will be addressed during the daily safety briefings, safe workplans, and in the Project-Specific Health and Safety Plan. Specific safety measures to be employed include high visibility PPE, lights, and back-up alarms.

2.4.2 Spill Prevention Control and Countermeasures

The potential impact of a release resulting from failure of various AWR systems was considered during development of the stormwater drainage plan. The following three potential sources of release were evaluated.

1) Silo failure during retrieval
2) Failure of one of the TTA tanks
3) Failure of the Slurry Transfer Line during retrieval

The potential impact of a failure at Silo 1 and 2 during retrieval is minimized by the design of the retrieval operation and by maintenance of the existing drainage system. First, the water flows to and from the silos during retrieval will be closely controlled to minimize the inventory of water in the silo and to assure that the addition of water is stopped immediately upon a silo failure. Second, as will be outlined in the ***Berm Excavation Plan*** included in this Remedial Design Package, excavation of the berms will be coordinated with the retrieval such that the level of material inside the silo will at all times be at least 5 feet below the level of the berm outside the silo. In addition to providing containment of any material potentially released due to failure of the Silo wall, maintaining the berm higher than the level of Silo material will assure containment of any water that would penetrate the Silo wall during waste retrieval. *As described in the Berm Excavation Plan, the berm material will be visually monitored for moisture and potential silo leaks during excavation to assess, if the berm soil has been potentially contaminated by K-65 slurry/supernate. This potentially contaminated material will be moved to a stockpile and radiologically surveyed and appropriately dispositioned.* Finally, as described in Section 2.3, drainage patterns and runoff controls will be maintained such that any release that was to escape the silo would be contained and directed to the WPSRC sump.

The release resulting from failure of one of the TTA tanks would be contained by the sealed concrete walls and floor of the TTA building. The floor drains to a sump, which would be used to pump the contained material to an appropriate location, such as one of the other TTA tanks.

The transfer pipe used to transfer the silo material from the Silo Waste Retrieval System to the TTA utilizes double-walled pipe to minimize the risk of pipe failure, the amount of material potentially released in the event of a pipe failure, the amount of material potentially released in the event of a pipe failure would be limited to the inventory contained in the line—approximately 250 gallons, thus minimizing the likelihood that the release would drain beyond the project area. As illustrated on Drawing 66FCD001, the area underneath the transfer line drains to the southeast stormwater basin. A concrete diversion berm will be installed to prevent drainage to the south directly into the Pilot Plant Drainage Ditch. A valve will be installed at the outlet of the

000108

basin to allow any material that was to reach the basin to be contained before reaching the Pilot Plant Drainage Ditch.

The design and construction of hazardous material storage tanks (e.g., fuel tanks and chemical tanks) and secondary containment will conform to the CFC drawings and specifications. Tanks are to be located away from heavy traffic and protected with bollards as necessary. Containers five gallons in size (minimum) are required to be labeled with the appropriate Hazardous Identification Label (diamond) as identified in the National Fire Protection Association (NFPA) Code NFPA-704.

Heavy equipment and mechanical equipment are to be maintained in good repair so as to minimized the release of engine, transmission, or other oils; engine coolants; or hydraulic fluids. Idle equipment is to be parked as far away from drainage channels as practical. A drip pan can be used under equipment that is leaking, with immediate action taken to repair the equipment or remove it from the FEMP site.

Fueling operations are to be performed with care, with allowances made for fuel expansion to prevent inadvertent small releases. Fuel tanks are to be contained within temporary dikes and inspected regularly. Spilled material is to be cleaned up as son as practical, placed in appropriate containers, and managed accordingly.

If a spill occurs at the AWR Project site, safe and practical methods available are to be used to prevent material from entering stormwater drainage channels. Spills are to be reported immediately to Fluor Fernald. Spill response kits containing absorbent material are to be available during construction, operations, and systems closure for the AWR Project and are to be located for easy access. Absorbent pillows, temporary earth dikes, or other means are to be located for easy access. Absorbent pillows, temporary earth dikes, or other means are to be readily available on-site for use, as appropriate, without risking personnel safety.

2.4.3 Inspections and Recordkeeping

The Construction Manager, or designee, is to conduct site inspections of the site during construction activities to confirm compliance with BMPs on a weekly basis, or within 24 hours of a rainfall event exceeding 0.5 inches within a 24-hour period. Items to be inspected include, but are not limited to, the following:

- Conditions of erosion controls, such as:
  - Silt fences,
  - Drainage ways,
  - Gully formation,
  - Areas needing seeding or reseeding, and
  - Access roads.
- General housekeeping on-site;
- Evidence of silt build-up or obstruction of the Silos 1 and 2 perimeter trench;

3157

- Evidence of poor fueling practices or leaking fuel tanks;
- Evidence of leaks from other tanks or equipment; and
- Stormwater channels inspected for oil sheen, debris, siltation, or other disturbance.
- Evidence of silt build-up or obstruction of the Silos 1 and 2 perimeter trench

A written record of the inspection, including all notifications and deficiencies, is to be kept in the field office trailer and made available to the FEMP personnel for review. Conditions noted during the inspections that require corrective action are to be repaired as soon as practical.

2.5 Erosion Control

Erosion Controls are placed during the construction phase to minimize soil movement from excavated or disturbed areas. These controls are to be installed prior to the initiation of excavation in the affected areas. These controls are based on standards specified in the FEMP Stormwater Pollution Prevention Plan and the Ohio Department of Natural Resources (ODNR) Rainwater and Land Development Manual, and were detailed in the AWR Project Site Preparation Package approved in May 2000. The measures outline in the AWR Site Preparation Package to lessen the environmental impact due to erosion are to be taken during AWR Project Construction include:

- Every effort is to be made to keep disturbed areas to a minimum;
- Existing natural drainage is to be maintained, where possible, to avoid disturbing areas within vegetation;
- Silt fences are to be placed at the bottom of slopes that are planned to be disturbed;
- Culvert entrances and exits are to be protected with riprap or geofabric;
- Seeding and mulching will follow construction as soon as practical;
- Overseeding or reseeding (including fertilizing when necessary) are to be performed as necessary until vegetation is established;
- Management and control of temporary stockpiles to prevent runoff
- Silt is to be removed from diversion ditches and silt fences, as required by the applicable construction specifications and at the end of construction. The silt will be disposed at an approved disposal site;
- Erosion control measures are to be inspected at least weekly or within 24 hours of a 0.5-in. rainfall; and
- Remediation of problems identified in a weekly site inspection are to be completed in a timely manner.

000110

- 3157

In addition to the erosion control measures specified in the Site Preparation Package, additional measures will be installed prior to excavation of berm material to preclude spread of contamination due to runoff during berm excavation. These erosion control features are detailed in the Berm Excavation Plan (Section 4 of the RD Package) and include:

- Silt fence surrounding the excavation area to prevent sediment runoff into the perimeter trench
- Sediment traps at the southwest corner of Silo 1
- Maintenance of the inlet protection installed around catch basins south of Silo 1 during site preparation construction
- Maintenance of the Silos perimeter trench to assure it remains free of obstruction

2.6 Secondary Waste Management

The primary waste stream for the AWR Project is identified as being the materials contained within the existing concrete silos. Secondary waste is generated during the process of construction and/or remediation of the primary waste stream.

The management of secondary waste, is described in detail in the Waste Handling Work Plan (Document N0. 40710-624-ACR007-01) for the AWR Project (Appendix 5.1 of this Environmental Control Plan). All secondary waste will be segregated, characterized, packaged, and dispositioned in accordance with site procedures. Based upon the Final Design, a Project Waste Identification and Disposition (PWID) Report will be prepared in accordance with procedure EW-1021, *Preparation of the Project Waste Identification and Disposition (PWID) Report.* The PWID will document the anticipated waste streams, generation rates, and Fluor Fernald-approved disposition for secondary waste resulting from AWR operations. FWENC will provide data on tracking of secondary waste generated to Fluor Fernald for updating of the appropriate inventory database. As waste is generated, the volumes of each waste stream will be tracked against the PWID, and the PWID will be updated as necessary due to any changes from the initial estimates. For the AWR Project, waste containers are to be placed in areas designated for such storage. Waste containers are to be clearly marked and arranged in a logical sequence for further waste management by FDF. In addition, the soil removal associated with excavations around the silos is addressed in the Berm Excavation Plan, Document No. 40710-624-P621-11, for the AWR Project.

2.7 Decant Sump Tank Waste Water Management

The K-65 decant sump tank located to the west of the K-65 Silos is part of the K-65 Silo drainage and stormwater management system. In 1994, a Maintenance Action Work Plan for the K-65 Decant Sump Tank was implemented to manage the liquid accumulating in the Decant Sump Tank. The Work Plan specifies monitoring of the liquid level in the tank and removal of the accumulated liquid at a decant sump tank level of 75 percent of available capacity, or more frequently if deemed necessary by the facility owner. This maintenance action is designed to mitigate the threat of overfilling the decant sump tank and minimize the potential for release of liquid to the surrounding environment.

- 3157

During the AWR Project, retrieval of the material from Silos 1 and 2, and excavation of berm material have the potential to impact the rate liquid accumulation in the Decant Sump Tank. In order to provide enhanced protection from release of liquid from the Decant Sump Tank, the following additional steps will be implemented:

1. The flow of the liquid infiltrate into the K-65 decant sump tank will be monitored and recorded both on operator roundsheets and on the automated process control system.

2. The level of liquid in the Decant Sump Tank will continue to be monitored.

3. The following action limits will be established:

   A. If the flow of liquid into the Decant Sump Tank exceeds the baseline flow rated based on historical data the following action is required:

   - Increase monitoring and note of the waste retrieval operation and silo area conditions at time of alarm.
   - Pump Tank at 60 percent capacity and analyze content for increased levels of K-65 materials.
   - Maintain increased monitoring.

   B. If the flow exceeds 5gpm, the following action is required:

   - Stop waste retrieval activity and note the conditions of waste retrieval operations and silo area.
   - Pump tank at 60 percent capacity and analyze contents for increased levels of K-65 material.

   C. If flow limits are not exceeded, the tank level limit established in the Maintenance Action Work Plan are to be maintained.

000112

3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SAFETY BASIS DOCUMENT

PRELIMINARY HAZARD ANALYSIS REPORT

ENVIRONMENTAL ALARA REPORT

DOCUMENT NO.
624-P622-10, Rev. 0
Appendix E

FOR THE

SILOS 1 AND 2
ACCELERATED WASTE RETRIEVAL PROJECT

SUBMITTED TO:

FLUOR FERNALD

CONTRACT NO. FSC 624

[X] A - Conforms to the Subcontract Requirements
[ ] B - Minor Comment - Incorporate and Resubmit
[ ] C - Revise and Resubmit
Sig. [signature] Date 2/24/6

000113

January 14, 2000

ECDC CONTROLLED
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3157

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Preliminary Hazard Analysis Report (PHAR)

Environmental ALARA Report
Preliminary Design Package
Revision 0

Recommended by:

Foster Wheeler ESQ Manager — Date: 1-14-00

Approved by:

Foster Wheeler Project Manager — Date: 1-14-00

000114

CONTENTS

3157

Environmental ALARA Review/Evaluation - Report and Checklist

ATTACHMENTS

ATTACHMENT 1. Radon Control System Performance Calculations

ATTACHMENT 2. Environmental Control Plan

000115

ACRONYMS

ALARA	as low as readily achieveable
ANSI	American National Standards Institute
ARAR	applicable, relevant, and appropriate Requirements
AWR	Accelerated Waste Retrieval Project
AWWT	Advanced Waste Water Treatment
CFR	*Code of Federal Regulations*
DCG	derived concentration guide
DOE	U.S. Department of Energy
FEMP	Fernald Environmental Management Project
FWENC	Foster Wheeler Environmental Corporation
HEPA	high-efficiency particulate air
NEPA	National Environmental Policy Act of 1969
OU4	Operable Unit 4
PEAPR	Project Evaluation for Air/Water Permit/Notification Request
RCS	Radon Control System
TTA	Transfer Tank Area

000116

3157

ENVIRONMENTAL ALARA REVIEW / EVALUATION – REPORT AND CHECKLIST

Environmental ALARA Log No:	Preliminary/Final Report: Preliminary

ALARA PHILOSOPHY

The ALARA philosophy adopted by the FEMP requires that any exposure to ionizing radiation to general employees, the public, or the environment shall be minimized to the extent that social, technical, economic, practical, and public policy considerations allow.

PART I. ENVIRONMENTAL ALARA REVIEW AND EVALUATION INFORMATION

1. Name/title of individual reviewing activity: Jerome B. Martin, AWR Radiation Safety Officer
2. Date review request to Environmental Compliance and review trigger (request for NEPA Services, PEAPR, etc.) (NOTE: If other significant documents will assist in this process, please note them and attach.) October 29, 1999
3. Ongoing or planned activity? Planned activity
4. Activity ID No, if any: Contract FSC624
5. Activity name: Accelerated Waste Retrieval (AWR) Project

PART II. DESCRIPTION OF ACTIVITY

1. Date of activity commencement: March 1, 2000
2. Location of the potential release (e.g., building, area): OU4 Silos 1 and 2, RCS stack
3. Date of identification of potential release: October 29, 1999
4. Personnel initiating assessment: Jerome B. Martin
5. Description of activity. Define the objective and scope of the issue to be analyzed: Construct a Radon Control System (RCS) to reduce radon emissions from Silos 1 and 2. Construct a Transfer Tank Area (TTA) to receive the waste currently in Silos 1 and 2. Construct a system to sluice and pump the waste currently in Silos 1 and 2 into the tanks in the TTA. Remove the berm around Silos 1 and 2. Remove the decant sump tank. Clean and paint/fix the contamination on the interior of Silos 1 and 2. The AWR Project activities will be conducted in accordance with the Environmental Control Plan (Document 624-P621-10).
6. Does the activity have the potential for a routine or nonroutine release of radionuclides (e.g., stack emissions, spills; include potential releases during construction)? Yes, the activity has the potential for both routine and nonroutine releases during construction and operation. The activity has the potential for spills of slurried K-65 waste material.

   NOTE: If the answer to Item 6 is "NO", then no further evaluation is required. Sign and date the checklist, send the original to Environmental Compliance, and place a copy in the Project File.

   DATE: _____ **SIGNATURE:** _____

7. Where is the material released or to be released for a future activity (e.g., air, water, soil, waste)? Indoors Yes Environment Yes
   Potential airborne and liquid releases indoors may occur from the tanks, piping, or sampling activities in the future RCS and TTA. Airborne releases to the environment will occur from the RCS stack. Liquid releases on site will occur from the AWR system to the Advanced Wastewater Treatment System. Potential liquid releases to the on-site environment may occur from the transfer lines between Silos 1 or 2 and the TTA.

PART II: DESCRIPTION OF ACTIVITY - Cont'd

8. Radionuclides potentially released:
   a. Radioactive material names, isotopes: Primary releases will be Rn-222 and Rn-220. Potential releases include Ac-227, Ac-228, Bi-210, Bi-211, Bi-212, Bi-214, Fr-223, Pa-231, Pa-234, Pa-234m, Pb-210, Pb-211, Pb-212, Pb-214, Po-210, Po-211, Po-212, Po-214, Po-215, Po-216, Po-218, Ra-223, Ra-224, Ra-226, Ra-228, Rn-219, Th-227, Th-228, Th-230, Th-231, Th-232, Th-234, Tl-207, Tl-208, U-234, U-235/236, U-238
   b. Physical state (e.g., gas, solid, liquid): Primary release is gas; potential release is liquid
   c. Drum/container markings (include FEMP Lot Markings): N/A
   d. Material Source/Origin: K-65 waste material in Silos 1 and 2

9. Amount released (in lbs., gallons, curies, or other) and source:
   a. To air: Refer to RCS Performance Calculations, Section V.D
   b. To water: Refer to RCS Performance Calculations, Section V.C
   c. To soil: Refer to RCS Performance Calculations
   d. To waste: Refer to RCS Performance Calculations
   e. To controlled and/or free release of material: Materials and equipment released will meet 10 CFR 835, Appendix D (or new ANSI N13.12) release standards.

10. How was amount determined (i.e., estimated, weighed, or otherwise measured)? Estimated on the basis of RCS Performance Calculations.

11. Off-site release (e.g., storm water, air release, other)? Primarily airborne release of radon.

12. Is a hazardous/mixed waste involved? List any special factors as a result: No mixed wastes are involved in AWR Project releases.

PART III: CONTROL OF RADIOACTIVE MATERIAL RELEASES

1. Describe or reference any protection options considered. Describe air emissions and water discharge control equipment, fugitive dust suppression, material lockdown, handling of waste, secondary containment, spill control equipment, controls on release of material, cleanup of spill material, administrative controls, and other:
   The AWR systems design uses best available technology. The air emissions will be pre-filtered and passed through four parallel carbon beds to adsorb more than 99% of the radon; the effluent from the carbon beds will be HEPA filtered before discharge from the RCS stack. The effluent from each carbon bed and the stack will be monitored in real-time for radon concentrations. In addition, the stack will be sampled and monitored for particulate airborne releases. The water will be sampled, analyzed, and treated as necessary to meet the AWWT waste acceptance criteria (WAC) before discharge to the AWWT. Any spills will be cleaned up to meet Fluor Fernald radiological control requirements.

2. How will waste be packaged/labeled/stored (location)/handled? The bulk of the waste will be stored in the four TTA tanks. A small percentage (0.1%) of the waste will be sampled and stored in drums in the sample storage area of the TTA. The drums will be labeled in accordance with Fluor Fernald labeling requirements.
   What procedures will be used? Applicable Fluor Fernald procedures (or equivalent FWENC Procedures) will be used to package, label, store, and handle AWR Project wastes. Actual Procedures used will be cited in the revised Environmental ALARA Report that will be Submitted with the Final Design package.

PART III: CONTROL OF RADIOACTIVE MATERIAL RELEASES - Cont'd

3. Release of materials and equipment - surface contamination levels. Before being released, will property be surveyed to determine whether both removable and total surface contamination (including contamination present on and under any coating) are in compliance with the levels given in Figure IV-1 of DOE Order 5400.5 and that the contamination has been subjected to the ALARA process. Describe or reference documentation of the ALARA process.
Before release from the controlled area, all material and equipment will be surveyed by Fluor Fernald Radiological Control Technicians (RCTs) using Fluor Fernald Procedure RP-0009 to ensure compliance with the Figure IV-1 of DOE Order 5400.5 release criteria and/or 10 CFR 835, Appendix D (or new ANSI N13.12) criteria. The ALARA process is further discussed in the ALARA Analysis (Document 624-P622-10A).

PART IV: ENVIRONMENTAL ALARA EVALUATION

1. Estimated performance of the control options. How much material will be controlled/ removed (e.g., %, pounds)? Identify advantages/disadvantages of each factor and control option. (Note: Use quantitative and qualitative methods when each is appropriate.)
The air control systems were designed using best available technology. The carbon beds will remove more than 99% of the radon from the silos before release from the RCS stack, as described in the RCS Performance Calculations. The HEPA filters will remove more than 99.97% of the particulates of the particulates greater than 0.3 micrometers in size from the stack effluent. The waste treatment system will use best available technology to reduce the contaminants in the water to the point that the water meets the Waste Acceptance Criteria for the AWWT.

2. Identify cost information for control options (as relevant to the decision): TBD

3. Applicable dose limits and derived concentration guidelines (DCGs) from DOE Order 5400.5. Dose impacts, if determined (e.g., dose to the maximally exposed individual, population dose). Are dose limits or DCGs exceeded? Refer to RCS Performance Calculations.

4. Analytical Solution. Present the results of quantitative analysis, if one is performed. (Note: According to DOE Order 5400.5, qualitative analyses are acceptable, in most instances, for ALARA Judgements, especially where potential doses are well below the dose limit.): Refer to RCS Performance Calculations.

5. What are the preferred control options and what is the basis for their selection. Present results of optimization, as appropriate (e.g., weighting factors, environmental impacts, associated risks, costs and changes in cost, sensitivity analysis, changes in societal impact (doses), etc. for options). (Note: According to RM-0015, the primary methods used to control exposure shall be physical design features, such as filtration and confinement. Administrative controls and procedural requirements shall be employed only as supplemental methods to control radiation exposure, unless physical design features are demonstrated to be impractical. For control of airborne radioactive material, the design shall be, under normal conditions, to avoid releases to the workplace atmosphere, the surrounding environment, and in any situation, to control the inhalation of such material by workers to levels that are ALARA; confinement and ventilation shall normally be used. Modifications to existing facilities and designs of new facilities shall meet the Environmental ALARA design criteria specified in DOE Orders 6430.1 and 5400.5.)
Refer to RCS Performance Calculations.

6. Environmental ALARA Decision. State the controls that constitute Environmental ALARA for the activity: Refer to the Environmental Control Plan (Document 624-P621-10).

PART IV: ENVIRONMENTAL ALARA EVALUATION — continued

7. Implementation and monitoring. Describe the methods to be used to monitor achieved performance against desired targets (e.g., ambient air monitoring, stack monitoring, water monitoring, surveillance, reporting): Continuous monitoring of radon as it exits the carbon beds and at the RCS stack will be used to ensure compliance with radon emission limits. Wastewater will be sampled and analyzed to ensure it meets the Waste Acceptance Criteria.

8. Recommended actions (advise consideration of additional factors, control options, develop additional information, etc.): Monitoring programs will be implemented as described in the Environmental Control Plan (Document 624-P621-10).

9. Justification for recommendations: Monitoring is consistent with ARARs.

PART V: FOLLOW UP ACTIONS

1. Reporting requirements, requests for temporary dose limits. [Note: DOE Operations Office shall notify the relevant Program Office(s) and the Deputy Assistant Secretary for Environment (EH-4) of actual or potential exposures of members of the public exceeding certain limits]:

2. Remaining issues/actions required:

3. Attachment List (Attach modeling output, reports, data, and other documents used as a basis for the ENVIRONMENTAL ALARA review/assessment:

Report By: J Martin **Report Date:** 1/14/00

Reviewed By: _____ **Review Date:** _____

000120

ENVIRONMENTAL ALARA REVIEW/EVALUATION - REPORT AND CHECKLIST

Distribution Form

ENVIRONMENTAL ALARA Log No.: _____

Follow-Up Action Required: _____

Action Item No.:	Responsible Individual:

Distribute To:

_____

_____

_____

FS-F-4918-RV0 (07/02/97)

000121

3157

ATTACHMENT 1

RADON CONTROL SYSTEM PERFORMANCE CALCULATIONS

000122

CALCULATION COVER SHEET

PROJECT Fernald Silos 1 & 2 AWR SUBJECT RCS Performance

CLIENT Fluor Daniel Fernald

CALCULATION NO. CA-FSC624-FM-001 PROJECT NO. FSC-624

NO OF SHEETS 42 DESIGN LEVEL 3

CALCULATION BY OTHERS ___ YES x NO PREPARER D. W. Hendrickson, P.E.

REVIEWED BY _____ DATE 12/16/99

ASSUMPTIONS THAT REQUIRE CONFIRMATION X YES ___ NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE AND INITIAL

Rev No	Affected Sheets	Prepared by Date	Checked by Date	Verified by Date
0	42			

CONTENTS

I. CRITERIA 3
A. Purpose of Calculation 3
B. Functional Requirements 3
II. APPLICABLE CODES AND STANDARDS 3
III. METHODOLOGY 3
IV. ASSUMPTIONS 4
V. CALCULATIONS 5
A. Carbon Bed ^{222}Rn Adsorption 5
1. Dynamic Adsorption Coefficient, K_a 5
2. Gas Rate Adjustment for Chiller Operation 7
3. Condensate Removal of ^{222}Rn 8
4. Carbon Bed Efficiency 10
5. Application of Chiller and Carbon Bed Analysis 11
B. Evaluation of ^{222}Rn Sources and Gas Concentrations ..... [illegible]
1. Phase 1, Silo Headspace Concentration Reduction ..... [illegible]
2. Phase 2A, Silo 1 Mining ..... 1[illegible]
3. Phase 2B, Silo 2 Mining 19
4. Phase 2C, TTA Ventilation 21
5. Phase 3, Future Waste Treatment Facility (FWTF) Operations and TTA Ventilation 22
6. Summary of ^{222}Rn Source and Concentration Calculations 23
C. Condensate ^{222}Rn Concentrations 24
D. Consequences of ^{222}Rn Stack Emissions 26
1. General Exposure Evaluation 26
2. Definition of Limits 27
3. On-Site Dispersion Coefficients 29
4. Off-Site Dispersion Coefficients 31
5. Design Basis Emission Consequences 32
E. Design Selections and Calculation Implementation 33
VI. REFERENCES 41

RCS PERFORMANCE CALCULATION

I. CRITERIA

A. Purpose of Calculation

The purpose of this calculation is to develop material balance estimates across the radon control system (RCS) of the Silos 1 & 2 Accelerated Waste Retrieval (AWR) at Fernald (Ohio).

B. Functional Requirements

The RCS must provide ventilation of silo and Transfer Tank Area (TTA) vessels. The RCS must chill the ventilation stream to improve radon adsorption and must adsorb radon from the gas stream. During some phases of operation, treated gas must be recycled to the vessels.

II. APPLICABLE CODES AND STANDARDS

Radon-222 (^{222}Rn) and its daughter emissions must result in exposure of less than:

Table 1: Ambient Air Limitations (Reference 1a)

Location	Distance (m)	Limit
Off-Site	350	0.5 pCi/L ^{222}Rn/L
On-Site	100	0.2 WL, instantaneous [1]
On-Site	100	0.02 WL, weekly average

Note: 1 "WL" limits are described in §V.D.2.

III. METHODOLOGY

The overall AWR and RCS operations are complex. To address this complexity, the full life of RCS operational conditions is developed and evaluated.

The methodology employed in this calculation is to:

- Evaluate performance of ^{222}Rn adsorption by carbon bed
- Evaluate ^{222}Rn sources and gas concentration during:
  - Phase 1, Silo headspace concentration reduction
  - Phase 2A, Silo 1 mining
  - Phase 2B, Silo 2 mining
  - Phase 2C, TTA ventilation
  - Phase 3, Future Waste Treatment Facility (FWTF) Operation and TTA Ventilation
- Evaluate ^{222}Rn in condensates
- Evaluate ^{222}Rn stack emissions and their consequences

- Application of the calculation to design choices and develop the mass balance of the RCS.

IV. ASSUMPTIONS

The following system assumptions are to be applied. Other specific instance assumptions are stated with individual calculations as necessary.

1. Gas streams entering the chiller are at 75°F and 100% RH.
2. Gas streams exiting the chiller and dryer are at 40°F and 15% RH.
3. Four carbon beds (40,000 lb each) are operated in parallel.
4. Gas rates from vessels to the RCS are:

Table 2: Vessel Gas Rates (acfm) to RCS

Phase	Silo 1	Silo 2	TTA 1A	TTA 1B	TTA 2A	TTA2B	FWTF
1	250	250	0	0	0	0	0
2A	250	250	125	125	0	0	0
2B	0	250	125	125	125	125	0
2C	0	0	125	125	125	125	0
3	0	0	125	125	125	125	500

5. Building ventilation to the stack is 8100 acfm at 75°F and 100%RH
6. Condensate will collect for 20 days, decay for 15 days, and be discharged or reused in the process.
7. Filled and filling TTA tanks will have 2 ft of water on top of settled solids for shielding and ^{222}Rn reduction.
8. Internal diameters of silos and TTA tanks are 80 ft and 66 ft, respectively.
9. Treated gas will not be recirculated to TTA tanks.
10. TTA tanks will have cone bottoms, 6 in drop over 33 ft radius, and domed tops with a height of 3 ft 6 in, sidewall height = 30 ft; tanks will be filled to a maximum of 27 ft sidewall.
11. Exposed surface areas of Silo waste material being mined will be 1.5 times the cross-section of the Silo.
12. Treated gas will not be recycled to a Silo undergoing mining.
13. No water cover will be maintained on residues of a silo undergoing mining.
14. Gas streams from the FWTF will be 420,000 pCi ^{222}Rn/L at 75°F and 100% RH.
15. TTA mining will require water cover removal.
16. Assumption 11 will apply for TTA mining as 1.5 times TTA tank cross-section.
17. On-site worker exposure limit is at a distance of 100 m from the stack, center of plu under winds of 0.5 m/s, and fumigation conditions with an inversion lid of 200 ft.
18. Stack height is 150 ft; stack discharge diameter is 3 ft.
19. Radon daughter concentration leaving the carbon bed is negligible.
20. Negligible heat transfer occurs across the carbon bed.

V. CALCULATIONS

A. Carbon Bed ^{222}Rn Adsorption

The performance of carbon bed adsorption (See Ref. 2) is expressed as:

$$C_o = C_i \cdot e^{-\left(\frac{\lambda \cdot K_a \cdot M}{F}\right)} \quad \text{(EQN 1)}$$

where:

C_o	=	Outlet concentration, pCi ^{222}Rn/L air
C_i	=	Inlet concentration, pCi ^{222}Rn/L air
$t_{1/2}$	=	^{222}Rn half-life, 3.8235 days (Reference 3)
λ	=	$\ln(2)/t_{1/2}$, 1.2589E-04/min for ^{222}Rn
M	=	Mass of carbon, g
F	=	Gas flow rate, L/min
K_a	=	^{222}Rn dynamic adsorption coefficient, L/g (pCi ^{222}Rn adsorbed/g carbon / pCi ^{222}Rn/L air)

1. Dynamic Adsorption Coefficient, K_a

a) K_a as a Function of Temperature

Reference 4 provides the following data of $K_a(T)$:

Table 3: Temperature Dependence of K_a

T (°C)	K_a (L/g)	T (°C)	K_a (L/g)
0	16.5	15	9.0
5	13.6	20	6.8
10	11.7	24	6.1
Reference State: 15% RH, atm. pressure			

Data reduction of Table 3 K_a data indicates that the best fit of data is found with a fourth-order expression of the form:

$$K_a(T) = EXP\left[b_1 + b_2 \cdot T^{-1} + b_3 \cdot T^{-2} + b_4 \cdot T^{-3}\right] \left(L/g\right) \quad \text{(EQN 2)}$$

Where:

T	=	Temperature, Kelvin

b_i = Regression coefficients
$b_1 = 1{,}030.4$; $b_2 = -895{,}870$; $b_3 = 2.9501E8$; $b_4 = -2.485E10$

Assumption 2 requires chiller gas product at 40°F

T = (40°F - 32°F)(5K/9°F) + 273.15K = 277.59 K

Applying EQN 2:

$$K_a(40°F) = EXP\left[1030.4 + \frac{-895{,}870}{277.59} + \frac{2.5901E8}{(277.59)^2} + \frac{-2.485E10}{(277.59)^3}\right] = 14.051\left(L/g\right)$$

b) K_a as a Function of Gas Stream Humidity

Reference 5 provides that K_a is a function of humidity with a decrease of 30% over increasing humidity from 0% relative humidity (RH) to 100% RH.

This function is expressed as:

$$K_a'(T,RH) = K_a(T,15\%)\cdot\left(1 - 0.3\left(\frac{RH - RH_0}{100}\right)\right)\left(L/g\right) \qquad \text{(EQN 3)}$$

where:

$K_a'(T,RH)$	=	Adsorption coefficient at T and RH
$K_a(T,15)$	=	Adsorption coefficient at T and RH = 15%
RH	=	Relative humidity, operational
RH_0	=	Relative humidity, standard state selection

Assumption 2 requires gas product at 40°F and 15% RH.

$$K_a'(40°F,15\%) = K_a(40°F,15\%)\cdot\left(1 - 0.3\left(\frac{15-15}{100}\right)\right) = 14.051\cdot(1 - 0.3(0))$$

$$K_a' = 14.051 \ L/g$$

For purposes of conservatism, the application of K_a will be limited to a value of 13 in this analysis.

2. Gas Rate Adjustment for Chiller Operation

From §V.A.1 above, ^{222}Rn adsorption is improved by chilling the gas stream. When chilled, water is condensed and removed resulting in lower gas rates to the carbon beds with lower moisture. Assumptions 2 and 3, and Reference 6 provide:

Table 4: Operating Stream Conditions

Location	T (°F)	RH (%)	Specific Volume (ft^3/lb dry air)	H (lb water/lb dry air)
Chiller Inlet	75	100%	13.884	0.01883
Chiller Outlet	40	15%	12.61	0.000768

The air (dry) mass entering and leaving the chiller and dryer is evaluated as (where Q [=] volume/time and in = out):

$$\dot{m}_{air} = \frac{Q_{in}}{\hat{V}_{inlet}} \frac{\frac{ft^3}{min}}{\frac{ft^3}{lb\,dry\,air}} [=] \frac{lb\,dry\,air}{min} \qquad \text{(EQN 4)}$$

and volume on exit is:

$$Q_{out} = \dot{m}_{air} \cdot \hat{V}_{outlet} = Q_{in} \cdot \frac{\hat{V}_{outlet}}{\hat{V}_{inlet}} [=] \frac{ft^3}{min} \qquad \text{(EQN 5)}$$

For conditions of Table 4:

$$\dot{m}_{air} = \frac{Q_{in}}{13.884} \frac{lb\,dry\,air}{min} \quad \textit{and} \quad Q_{out} = \frac{12.61}{13.884} \cdot Q_{in} = 0.90825 \cdot Q_{in} \frac{ft^3}{min}$$

The amount of condensate generated is calculated by difference across the chiller and dryer as:

$$\dot{m}_{H_2O,in} = \dot{m}_{air} \left(\frac{lb\,dry\,air}{min} \right) \cdot H_{in} \left(\frac{lb\,H_2O}{lb\,dry\,air} \right) [=] \frac{lb\,H_2O}{min} \qquad \text{(EQN 6)}$$

$$\dot{m}_{H2O,out} = \dot{m}_{air}\left(\frac{\text{lb dry air}}{\text{min}}\right)\cdot H_{out}\left(\frac{\text{lb } H_2O}{\text{lb dry air}}\right)[=]\frac{\text{lb } H_2O}{\text{min}} \qquad \text{(EQN 7)}$$

Combining Equations 4, 6, and 7 across the chiller and dryer,

$$\dot{m}_{Cond} = \dot{m}_{H2O,in} - \dot{m}_{H2O,out} = \frac{Q_{in}}{\hat{V}_{inlet}}\cdot(H_{in} - H_{out})\frac{\text{lb } H_2O}{\text{min}} \qquad \text{(EQN 8)}$$

$$Q_{Cond} = \frac{\dot{m}_{Cond}\,\frac{\text{lb } H_2O}{\text{min}}}{\rho_{H2O}\,\frac{\text{lb } H_2O}{\text{L}}}[=]\frac{\text{L}}{\text{min}} \qquad \text{(EQN 9)}$$

where: ρ_{H2O} = density of water, 2.20462 lb/L.

3. Condensate Removal of ^{222}Rn

The liquid condensate will absorb radon from the gas stream. Reference 7 provides radon equilibrium solubility (calculation provided in §V.C.) as:

$$S_{222Rn,aq.} = \frac{\frac{0.55017 \text{ pCi } ^{222}Rn}{\text{L water}}}{\frac{\text{pCi } ^{222}Rn}{\text{L air}}}$$

The concentration of ^{222}Rn in the liquid is collected is:

$$C_{222Rn,Cond} = S_{222Rn,aq.}\left(\frac{\text{pCi/L water}}{\text{pCi/L air}}\right)\cdot C_{222Rn,air\,in}\left(\frac{\text{pCi}}{\text{L air}}\right)[=]\frac{\text{pCi}}{\text{L water}} \qquad \text{(EQN 10)}$$

where:

$C_{222Rn,air\,in}$ = concentration of ^{222}Rn in gas entering chiller/dryer, pCi/L

The activity of ^{222}Rn in the condensate is calculated as:

000130

$$A_{222Rn,Cond} = Q_{Cond}\left(\frac{\text{L}}{\text{min}}\right)\cdot C_{222Rn,Cond}\left(\frac{\text{pCi}}{\text{L}}\right)[=]\frac{\text{pCi}}{\text{min}} \qquad \text{(EQN 11)}$$

And the activity of the inlet gas is:

$$A_{222Rn.In} = Q_{In}\left(\frac{L}{min}\right)\cdot C_{222Rn.In}\left(\frac{pCi}{L}\right)[=]\frac{pCi}{min} \qquad \textbf{(EQN 12)}$$

Thus, the activity of the gas exiting the chiller/dryer is:

$$A_{222Rn.Out} = A_{222Rn.In} - A_{222Rn.Cond} \qquad \textbf{(EQN 13)}$$

The gas stream ^{222}Rn concentration is found by EQN 13 and EQN 5 with substitution by EQNs 12, 11, 8, 9, and 10:

$$C_{222Rn.Out} = \frac{A_{222Rn.In} - A_{222Rn.Cond}}{Q_{Air\,Out}}\frac{pCi/min}{L/min}[=]\frac{pCi}{L}$$

$$= \frac{A_{222Rn.In} - A_{222Rn.Cond}}{Q_{In}}\cdot\frac{\hat{V}_{In}}{\hat{V}_{Out}}$$

$$= \frac{Q_{In}\cdot C_{222Rn.In} - Q_{Cond}\cdot C_{222Rn.Cond}}{Q_{In}}\cdot\frac{\hat{V}_{In}}{\hat{V}_{Out}}$$

$$= \left(\frac{Q_{In}\cdot C_{222Rn.In}}{Q_{In}} - \frac{Q_{In}}{\hat{V}_{In}}\cdot\frac{(H_{In}-H_{Out})}{\rho_{H2O}}\cdot\frac{S_{222Rn.aq.}\cdot C_{222R.In}}{Q_{In}}\right)\cdot\frac{\hat{V}_{In}}{\hat{V}_{Out}}$$

$$C_{222Rn.Out} = C_{222R.In}\cdot\left(1 - S_{222Rn.aq.}\cdot\frac{(H_{In}-H_{Out})}{\hat{V}_{In}\cdot\rho_{H2O}}\right)\cdot\frac{\hat{V}_{In}}{\hat{V}_{Out}} \qquad \textbf{(EQN 14)}$$

where: $\hat{V}\left(L/lb\,dry\,air\right) = \hat{V}\left(ft^3/lb\,dry\,air\right)\cdot 28.317\,L/ft^3$

Evaluating EQN 14 relative to $C_{222Rn.In}$:

$$C_{222Rn.Out} = C_{222R.In} \cdot \left(1 - \left(\frac{\frac{0.55017\ \text{pCi}\ ^{222}\text{Rn}}{\text{L water}}}{\frac{\text{pCi}\ ^{222}\text{Rn}}{\text{L air}}}\right) \cdot \frac{(0.01883 - 0.000768)}{\frac{13.884\,\text{ft}^3}{\text{lb dry air}} \cdot \frac{28.317\text{L}}{\text{ft}^3} \cdot \frac{2.20462\ \text{lb}}{L}}\right) \cdot \frac{\frac{13.884\,\text{ft}^3}{\text{lb dry air}}}{\frac{12.61\,\text{ft}^3}{\text{lb dry air}}}$$

$$C_{222Rn.Out} = 1.1010 \cdot C_{222R.In}\ \text{pCi}/\text{L} \qquad \textbf{(EQN 15)}$$

4. Carbon Bed Efficiency

Reforming EQN 1 and defining the carbon bed efficiency (η):

$$\frac{C_o}{C_i} = 1 - \eta = e^{-\left(\frac{\lambda \cdot K_a \cdot M}{F}\right)} \qquad \textbf{(EQN 16)}$$

$$\eta = 1 - e^{-\left(\frac{\lambda \cdot K_a \cdot M}{F}\right)}$$

where:

F = Chilled air rate to carbon beds = $Q_{Out|Chiller}$

For varying system flow rates over four carbon beds (Assumption 3, M = 4*40,000 lb = 72,574,784 g), the efficiencies of the beds are tabulated in Table 5.

Table 5: Carbon Bed Efficiency with Chilled Gas Rate

Q_{in} (ft^3/min)	Q_{out} (ft^3/min) EQN 5	F (L/min)	η EQN 16
125	113.53	3,214.9	1
250	227.06	6,429.7	1
375	340.59	9,644.6	0.999996
500	454.13	12,859	0.999903
625	567.66	16,074	0.999382
750	681.19	19,289	0.997883
875	794.72	22,504	0.994898
1,000	908.25	25,719	0.99013

5. Application of Chiller and Carbon Bed Analysis

3157

Example Calculation:

- Assume Phase 1 operations
- Assume Silo headspace ^{222}Rn concentrations of:
  - Silo 1: 252,173 pCi/L
  - Silo 2: 249,598 pCi/L

Table 6: Source Terms and Ventilation		
Vessel	Q (ft^3/min) [Table 2]	$C_{222Rn,air}$ (pCi/L)
Silo 1	250	252,173
Silo 2	250	249,598
Sum	500	250,885.4

From Table 5: $Q_{Out|Chiller} = 454.13\ ft^3/min$

$$EQN\ 8 \Rightarrow \dot{m}_{Cond} = \frac{\frac{500\,ft^3}{min}}{\frac{13.884\,ft^3}{lb\,dry\,air}} \cdot (0.01883 - 0.000768)\frac{lbH_2O}{lb\,dry\,air} = 0.65041\frac{lb\,H_2O}{min}$$

$$EQN\ 9 \Rightarrow Q_{Cond} = \frac{0.65041}{2.20462}\frac{\frac{lb\,H_2O}{min}}{\frac{lb\,H_2O}{L}} = 0.29502\frac{L\,water}{min}$$

$$EQN\ 10\ \&\ 11 \Rightarrow A_{222Rn.Cond} = \frac{0.29502\,L\,water}{min} \cdot \frac{0.5501744\,pCi/L\,water}{pCi/L\,air} \cdot \frac{250{,}885.4\,pCi}{L\,air} = 40{,}721.7\frac{pCi}{min}$$

$$EQN\ 15 \Rightarrow C_{222Rn.Out} = 1.1010 \cdot 250{,}885.4\frac{pCi}{L} = 276{,}225.9\frac{pCi}{L}$$

Across the carbon beds, using EQN 16 and Table 5:

$$C_o = C_i \cdot (1 - \eta) \qquad \text{(EQN 17)}$$

$$C_o = 276{,}225.9\frac{pCi}{L} \cdot (1 - 0.999903) = 26.91\frac{pCi}{L}$$

∴ For purposes of hand calculation, recirculation of the treated gas may be neglected. This recycle will be included in spreadsheet forms of this equation set.

B. Evaluation of ^{222}Rn Sources and Gas Concentrations

1. Phase 1, Silo Headspace Concentration Reduction

The time-dependent headspace concentration of a vessel under recirculatory ventilation may be expressed as:

$$C_t = \frac{E/V}{\left(\lambda + \frac{\eta Q}{V}\right)} \cdot \left(1 - e^{-\left(\lambda + \frac{\eta Q}{V}\right)t}\right) + C_0 \cdot e^{-\left(\lambda + \frac{\eta Q}{V}\right)t} \; [=] \frac{\text{pCi}}{\text{L}} \qquad \textbf{(EQN 18)}$$

where:

C_t	=	Concentration at time t, pCi/L
C_0	=	Initial concentration, pCi/L
E	=	Emission rate from materials to the headspace, pCi/min
V	=	Headspace volume, L
η	=	Reduction in radon across treatment beds
Q	=	Ventilation flowrate through headspace, L/min
λ	=	Decay constant, 1.2589E-04/min for ^{222}Rn
t	=	Duration of ventilation, min

The term $\left(\lambda + \frac{\eta Q}{V}\right)$ in EQN 18 reflects decay of ^{222}Rn and displacement frequency with treated gas return.

To apply EQN 18, the emission rate (E) must be evaluated. The silos are currently unventilated. Evaluating EQN 18 as $t \rightarrow \infty$ and $Q = 0$, and rearranging:

$$E = C_\infty \cdot V \cdot \lambda \qquad (t \rightarrow \infty, Q = 0) \qquad \textbf{(EQN 19)}$$

References 8 and 9 provide:

Table 7: Silo Headspace Concentrations and Volumes

Silo	C (pCi/L)	V (L)
1	1.82E+07	7.90E+05
2	1.13E+07	1.27E+06

Substituting Table 7 values into EQN 19:

$$E_{Silo1} = \frac{18.2\text{E}6\,\text{pCi}}{\text{L}} \cdot 0.76\text{E}6\text{L} \cdot \frac{1.26\text{E}-4}{\text{min}} = 1.8101\text{E}9\,\frac{\text{pCi}}{\text{min}}$$

$$E_{Silo2} = \frac{11.3E6\ pCi}{L} \cdot 1.27E6L \cdot \frac{1.26E-4}{min} = 1.8067\ E9 \frac{pCi}{min}$$

Evaluating EQN 18 using ventilation rates from Table 2, and C_0 and V from Table 7, over varying time of ventilation, the headspace concentrations are calculated and provided in Table 8.

Table 8: Time Dependent Phase 1 Silo Headspace ^{222}Rn

t (min)	Silo 1 C_t (pCi/L)	Silo 2 C_t (pCi/L)
10	1.66E+07	1.07E+07
100	7.49E+06	6.50E+06
500	443,159	888,950
1,000	254,205	286,590
1,440	252,210	252,611
7,200	252,173	249,598
14,400	252,173	249,598

Table 8 values demonstrate steady-state concentrations are achieved in one to two days. The five-day values will be used in this analysis for silo ventilation.

As seen in the example calculation of §V.A.5, above, the Phase 1, steady-state, carbon bed ^{222}Rn exhaust concentration will be: $C_o = 26.91\,{}^{pCi}/_{L}$.

2. Phase 2A, Silo 1 Mining

   a) Silo 2 Headspace

During this Phase Silo 2 will continue under ventilation, Silo 1 will be mined, and TTA tanks 1A and 1B will be filled.

From Table 2: 750 cfm will be treated; 250 cfm from Silo 2
From Table 5: $\eta = 0.997883$
From Table 7: $V_{Silo2} = 1.27E+06$ L
Evaluating EQN 18 for this efficiency, noting that:

$$\left(\lambda + \frac{\eta \cdot Q}{V}\right)_{Silo2} = \left(\frac{1.26E-04}{min} + \frac{0.997883 \cdot \frac{250 ft^3}{min} \cdot \frac{28.317 L}{ft^3}}{1.27E+6\ L}\right) = \frac{5.688E-3}{min}$$

A five-day, steady-state, concentration from Silo 2 will be:

$$EQN18 \Rightarrow C_{Silo2.2A} = \frac{1.8067E9pCi/min/1.27E6L}{5.688E-3/min} \cdot \left(1 - e^{-\left(\frac{5.688E-3}{min}\right)7200\,min}\right) + \frac{249{,}598pCi}{L} \cdot e^{-\left(\frac{5.688E-3}{min}\right)7200\,min}$$

$$C_{Silo2.2A} = 250{,}092.0\frac{pCi}{L}$$

b) Tank TTA 1A and TTA 1B Emissions

The TTA tanks, unlike the initial Silo condition, will not have a clay barrier. Their radon emissions must be evaluated other than by EQNs 18 and 19 directly.

In §V.B.1 emissions of radon were evaluated from known present concentrations. At outset, these vessels will have no material to generate radon. Reference 10 provides emanation of radon from uranium mill tailings as a function of radium content as:

$$\dot{E} = \frac{0.6pCi\ ^{222}Rn/m^2s}{pCi\ ^{226}Ra/g}$$

Radon, with a high solubility in water, may be reduced in emission to the headspace by placement of water above the tailings. Reference 1d provides this functionality as an efficiency in reduction:

$$\eta_{Rn,H2O} = 1 - e^{-0.0717 \cdot depth(in)} \qquad \textbf{(EQN 20)}$$

The surface emanation rate and EQN 20 reduction may be applied to evaluate emission of radon to the headspace as:

$$E = C_{226Ra} \cdot \dot{E} \cdot A \cdot e^{-0.0717 \cdot depth(in)} [=] \frac{pCi}{min} \qquad \textbf{(EQN 21)}$$

where:

C_{226Ra}	=	Concentration of ^{226}Ra in the solids, pCi/g
A	=	Area of solid surface, vessel cross-section, m^2
depth	=	height of water on top of tailings, inches

and a conversion of seconds/minute is required.

Reference 1b provides 95% confidence interval radium content of silo wastes as:

Table 9: Silo Waste ^{226}Ra Content (95% CI)	
Silo	^{226}Ra (pCi/g)
1	477,000
2	263,000

Assumptions 7 and 8 provide 2 ft of water cover in 66-ft-diameter tanks. Application of these inputs for Silo 1 wastes entering TTA tanks 1A and 1B to EQN 21 yields:

$$E_{TTA1A/B} = \frac{477{,}000\,\text{pCi}\,^{226}\text{Ra}}{\text{g}} \cdot \frac{0.6\,\text{pCi}\,^{222}\text{Rn/m}^2\text{s}}{\text{pCi}\,^{226}\text{Ra/g}} \cdot \left(\frac{66\text{ft}}{2} \cdot \frac{0.3048\,\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot e^{-0.0717\left(2\text{ft}\frac{12\text{in}}{\text{ft}}\right)} \cdot \frac{60\,\text{s}}{\text{min}}$$

$$E_{TTA1A/B} = 9.7655E+8\,\frac{\text{pCi}}{\text{min}}$$

Looking ahead to Silo 2 waste materials:

$$E_{TTA2A/B} = \frac{263{,}000\,\text{pCi}\,^{226}\text{Ra}}{\text{g}} \cdot \frac{0.6\,\text{pCi}\,^{222}\text{Rn/m}^2\text{s}}{\text{pCi}\,^{226}\text{Ra/g}} \cdot \left(\frac{66\text{ft}}{2} \cdot \frac{0.3048\,\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot e^{-0.0717\left(2\text{ft}\frac{12\text{in}}{\text{ft}}\right)} \cdot \frac{60\,\text{s}}{\text{min}}$$

$$E_{TTA2A/B} = 5.3843E+8\,\frac{\text{pCi}}{\text{min}}$$

Within the TTA tanks, with no recirculation (See Assumption 9), the steady-state concentration may be determined as a reduction of EQN 18 as:

$$C_t = \frac{E/V}{\left(\lambda + \frac{Q}{V}\right)} \quad [=] \quad \frac{\text{pCi}}{\text{L}} \qquad \textbf{(EQN 22)}$$

where variables are defined as above, but V varies with the extent of fill of the tank.

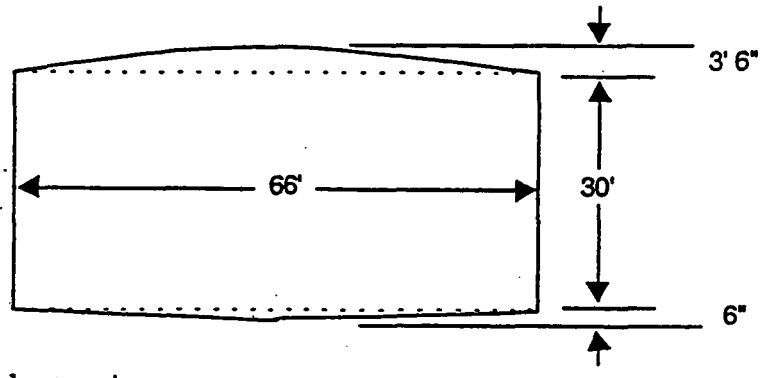
As V varies in EQN 22, the time to turn over the headspace changes allowing the concentration to change (increase). The range of V may be established by the design of the tanks (See Assumption 10) as depicted in Figure 1.

The volume of the dome is:

000137

$$V_{Dome} = \frac{\pi \cdot h \cdot r^2}{4} = \frac{\pi \cdot (3.5\text{ft}) \cdot (33\text{ft})^2}{4} \cdot \frac{28.317\,\text{L}}{\text{ft}^3} = 84{,}768\,\text{L} \qquad \textbf{(EQN 23)}$$

Figure 1: TTA Tank Sketch



The volume of the cone bottom is:

$$V_{Cone} = \frac{\pi \cdot r^2 \cdot h}{3} = \frac{\pi \cdot (33\,\text{ft})^2 \cdot (0.5\,\text{ft})}{3} \cdot \frac{28.317\,\text{L}}{\text{ft}^3} = 16{,}146\,\text{L} \qquad \text{(EQN 24)}$$

The volume of the sidewall area is:

$$V_{Upright} = \pi \cdot r^2 \cdot h = \pi \cdot (33\,\text{ft})^2 \cdot (30\,\text{ft}) \cdot \frac{28.317\,\text{L}}{\text{ft}^3} = 2.9063\,E\,6\,\text{L} \qquad \text{(EQN 25)}$$

The initial volume of each TTA tank is:

$$V_{Init} = V_{Dome} + V_{Cone} + V_{Upright} = 3.007_2\,E\,6\,\text{L} \qquad \text{(EQN 26)}$$

At maximum fill the gas space, V_{min}, is (Assumption 10):

$$V_{min} = V_{Init} - V_{Cone} - \frac{27}{30} \cdot V_{Upright} = 375{,}400\,\text{L} \qquad \text{(EQN 27)}$$

Applying EQN 22 over the filling of the tank from V_{Init} to V_{min} for Silo 1 wastes, and again anticipating the calculation for Silo 2 wastes, the gas phase ^{222}Rn in the TTA tanks (Q from Assumption 4) are provided in Table 10.

Table 10: TTA Tank ^{222}Rn Concentrations

V (L)	C (pCi ^{222}Rn/L)	
	Silo 1 Waste	Silo 2 Waste
3.00E+06	249,293	137,451
2.50E+06	253,364	139,695

Table 10: TTA Tank ^{222}Rn Concentrations

V (L)	C (pCi ^{222}Rn/L)	
	Silo 1 Waste	Silo 2 Waste
2.00E+06	257,570	142,015
1.50E+06	261,919	144,412
1.00E+06	266,417	146,892
500,000	271,072	149,459
375,400	272,257	150,112
350,000	**272,500**	**150,246**

For conservative purposes (and long term storage) a maximum (V=350,000 L) gas concentration will be used.

c) Silo 1 Emissions During Mining

During Phase 1 operations, this vessel is operated with a clay cap for reducing radon emissions. During mining, the clay must be removed to excavate the tailings. The tailings will be disturbed. To account for these conditions, Assumption 11 provides an effective surface area of 1.5 times the silo cross-section. With no water cover on the Silo 1 waste and no gas recirculation to this silo (See Assumptions 12 & 13), EQN 21 reduces to:

$$E_{Silo1.2A} = C_{226Ra} \cdot E' \cdot A' \,[=]\, \frac{\text{pCi}}{\text{min}} \qquad \textbf{(EQN 28)}$$

where:

A' = Effective area of silo waste surface, 1.5*A, m^2

Applying Silo dimensions of Assumption 8 and waste composition of Table 9,

$$EQN\,28 \Rightarrow E_{Silo1.2A} = \frac{477{,}000\,\text{pCi}^{226}\text{Ra}}{\text{g}} \cdot \frac{0.6\,\text{pCi}^{222}\text{Rn/m}^2\text{s}}{\text{pCi}^{226}\text{Ra/g}} \cdot 1.5 \cdot \left(\frac{80\text{ft}}{2} \cdot \frac{0.3048\,\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot \frac{60\text{s}}{\text{min}}$$

$$E_{Silo1.2A} = 1.2028sE+10\,\frac{\text{pCi}}{\text{min}}$$

Reference 1c provides current waste and clay volumes in the silos as:

Table 11: Silo Material Inventories

Material	Silo 1		Silo 2	
	yd^3	m^3	yd^3	m^3
K-65	4,293	3,282	3,719	2,843
Clay	471	360	411	314
Total	4,764	3,642	4,130	3,158

Tables 7 and 11 values define the range of Silo 1 headspace volumes from:

V_{Init} = 0.79 E6 L

V_{Final} = $V_{Init} + V_{waste}$ = 0.79 E6 + 3.642 E6 = 4.432 E6 L.

Applying EQN 22 from V_{Init} to V_{Final}, the Silo 1 ^{222}Rn headspace concentration varies as tabulated in Table 12. Q is provided in Table 2.

Table 12: Silo 1, Phase 2A ^{222}Rn Headspace Concentration

V(L)	C (pCi ^{222}Rn/L)
7.90E+05	1,675,591
1.00E+06	1,669,443
1.147E+06	**1,665,166**
1.50E+06	1,654,985
2.00E+06	1,640,774
2.50E+06	1,626,806
3.00E+06	1,613,073
3.50E+06	1,599,571
4.00E+06	1,586,292
4.40E+06	1,575,827

For conservative purposes, the radon concentration corresponding to V = 1.147 E6 L is chosen. This volume represents the headspace volume when the clay cap is removed.

d) Phase 2A Gas Treatment

The composite gas stream in Phase 2A, from §§V.B.2.a, V.B.2.b, V.B.2.c, and Table 2 are summarized in Table 13. The combined Table 13 treatment stream to the chiller is found to be 729,253 pCi/L as:

$$C_{222Rn.In.2A} = \frac{\sum C \cdot Q}{\sum Q} \qquad \text{(EQN 29)}$$

Table 13: Phase 2A Gas Streams		
Vessel	Q (ft^3/min)	C (pCi ^{222}Rn/L)
Silo 1	250	1,665,166
Silo 2	250	250,092
TTA 1A	125	272,500
TTA 1B	125	272,500
Total	750	729,252.8

The chiller outlet and carbon bed inlet concentration is:

$$EQN15 \Rightarrow C_{222Rn.Out.2A} = 1.1010 \cdot 729{,}252.8 \frac{pCi}{L} = 802{,}910.4 \frac{pCi}{L}$$

Applying treatment efficiency from Table 5 and EQN 17:

$$C_{o.2A} = 802{,}910.4 \frac{pCi}{L} \cdot (1 - 0.997883) = 1{,}699.85 \frac{pCi}{L}$$

3. Phase 2B, Silo 2 Mining

a) Silo 1 Headspace

Following Silo 1 mining in Phase 2A, no ventilation of Silo 1 will be conducted. No ^{222}Rn contribution will be derived from this vessel.

b) Tank TTA 1A and 1B Emissions

During Phase 2B, these vessels will be filled and will exhibit headspace concentrations of ^{222}Rn of 272,500 pCi/L (see §V.B.2.b, Table 10).

c) Tank TTA 2A and 2B Emissions

During Phase 2B, these vessels will be filled and will exhibit headspace concentrations of ^{222}Rn of 150,246 pCi/L (see §V.B.2.b, Table 10).

d) Silo 2 Headspace

In the manner of §V.B.2.c, the initial and final Silo 2 gas space volumes from Tables 7 and 11 are:

V_{Init} = 1.27E+06 L

V_{Final} = 4.428E+06 L.

Applying EQN 28 with Table 9 concentrations and Assumption 8 dimensions:

$$EQN\,28 \Rightarrow E_{Silo2.2B} = \frac{263{,}000\,\text{pCi}}{\text{g}} \cdot \frac{0.6\text{pCi}\,^{222}\text{Rn/m}^2\text{s}}{\text{pCi/g}} \cdot 1.5 \cdot \left(\frac{80\text{ft}}{2} \cdot \frac{0.3048\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot \frac{60s}{\text{min}}$$

$$E_{Silo2.2B} = 6.63207E+09\,\frac{\text{pCi}}{\text{min}}$$

Applying EQN 22 from V_{init} to V_{final}, the ^{222}Rn headspace concentration varies as tabulated in Table 14. Q is provided in Table 2.

For conservative purposes, the radon concentration of Table 14 corresponding to V = 1.5E6 L is chosen. This volume corresponds to the volume when the clay cap is removed.

Table 14: Silo 2, Phase 2B ^{222}Rn Headspace Concentration

V(L)	C (pCi ^{222}Rn/L)
1.27E+06	916,147
1.50E+06	**912,497**
2.00E+06	904,662
2.50E+06	896,960
3.00E+06	889,388
4.00E+06	874,622
4.40E+06	868,852

e) Phase 2B Gas Treatment

The composite gas stream in Phase 2B, from §§V.B.3.b, V.B.3.c, V.B.3.d, and Table 2 are summarized in Table 15. The combined Table 15 treatment stream to the chiller is found through EQN 29 to be 445,081 pCi/L.

The chiller outlet and carbon bed inlet concentration is:

$$EQN\,15 \Rightarrow C_{222Rn.Out.2B} = 1.1010 \cdot 445{,}081.1\,\frac{\text{pCi}}{\text{L}} = 490{,}036.2\,\frac{\text{pCi}}{\text{L}}$$

Table 15: Phase 2B Gas Streams		
Vessel	Q (ft^3/min)	C (pCi ^{222}Rn/L)
Silo 2	250	912,497
TTA 1A	125	272,500
TTA 1B	125	272,500
TTA 2A	125	150,246
TTA 2B	125	150,246
Total	750	445,081.1

Applying treatment efficiency from Table 5 and EQN 17:

$$C_{o.2A} = 490{,}036.2\frac{\text{pCi}}{\text{L}} \cdot (1 - 0.997883) = 1{,}037.46\frac{\text{pCi}}{\text{L}}$$

4. Phase 2C; TTA Ventilation

During Phase 2C, neither silo will contribute to the ventilation stream. The TTA components will contribute as described in §§V.B.3.b and V.B.3.c and Table 2. These conditions are summarized in Table 16, with a composite gas stream concentration through EQN 28 of 211,373 pCi/L.

Table 16: Phase 2C Gas Streams		
Vessel	Q (ft^3/min)	C (pCi ^{222}Rn/L)
TTA 1A	125	272,500
TTA 1B	125	272,500
TTA 2A	125	150,246
TTA 2B	125	150,246
Total	500	211,373.3

The chiller outlet and carbon bed inlet concentration is:

$$EQN\,15 \Rightarrow C_{222Rn,Out,2C} = 1.1010 \cdot 211{,}373.3\frac{\text{pCi}}{\text{L}} = 232{,}722.9\frac{\text{pCi}}{\text{L}}$$

Applying treatment efficiency from Table 5 and EQN 17:

$$EQN\,17 \Rightarrow C_{o.2C} = 232{,}722.9\frac{\text{pCi}}{\text{L}} \cdot (1 - 0.999903) = 22.67\frac{\text{pCi}}{\text{L}}$$

5. Phase 3, Future Waste Treatment Facility (FWTF) Operations and TTA Ventilation

During Phase 3, a treatment plant for the silos wastes returns a gas stream (Assumption 14) at 500 cfm with 420,000 pCi ^{222}Rn/L. As the radon must be sourced, one may infer that at least one of the TTA vessels have been, or are undergoing, mining.

The concentration of gases during TTA mining may be evaluated on the basis of the headspace volume and EQNs 22 and 28.

Assumptions 7, 10, 15, and V_{min} of §V.B.2.b yield a gas space volume minimum of a TTA tank under mining as **V = 568,755 L.**

For mining of Silo 1 wastes (TTA 1A or 1B), EQN 27 may be applied as in §V.B.2.c based upon Table 9 and Assumption 16:

$$EQN\,28 \Rightarrow E_{TTA1A/B.3} = \frac{477{,}000\,\text{pCi}\,^{226}\text{Ra}}{\text{g}} \cdot \frac{0.6\,\text{pCi}\,^{222}\text{Rn}/\text{m}^2\text{s}}{\text{pCi}\,^{226}\text{Ra/g}} \cdot 1.5 \cdot \left(\frac{66\text{ft}}{2} \cdot \frac{0.3048\,\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot \frac{60\text{s}}{\text{min}}$$

$$E_{TTA1A/B.3} = 8.18691E+9\,\frac{\text{pCi}}{\text{min}}$$

And

$$EQN\,22 \Rightarrow C_{TTA1A/B.3} = \frac{E/V}{\left(\lambda + \frac{Q}{V}\right)} = \frac{8.18691\text{E9}\,\text{pCi/min}/568{,}755\text{L}}{\left(\frac{1.2589\text{E}-4}{\text{min}} + \frac{(125\text{ft}^3/\text{min})\cdot(28.317\text{L/ft}^3)}{568{,}755\text{L}}\right)} = 2{,}267{,}082\,\frac{\text{pCi}}{\text{L}}$$

Comparably, for Silo 2 waste (TTA 2A or 2B):

$$EQN\,28 \Rightarrow E_{TTA2A/B.3} = \frac{263{,}000\,\text{pCi}\,^{226}\text{Ra}}{\text{g}} \cdot \frac{0.6\,\text{pCi}\,^{222}\text{Rn}/\text{m}^2\text{s}}{\text{pCi}\,^{226}\text{Ra/g}} \cdot 1.5 \cdot \left(\frac{66\text{ft}}{2} \cdot \frac{0.3048\,\text{m}}{\text{ft}}\right)^2 \cdot \pi \cdot \frac{60\text{s}}{\text{min}}$$

$$E_{TTA2A/B.3} = 4.5139sE+9\,\frac{\text{pCi}}{\text{min}}$$

And

$$EQN\,22 \Rightarrow C_{TTA2A/B.3} = \frac{E/V}{\left(\lambda + \frac{Q}{V}\right)} = \frac{4.51395\text{E9}\,\text{pCi/min}/568{,}755\text{L}}{\left(\frac{1.2589\text{E}-4}{\text{min}} + \frac{(125\text{ft}^3/\text{min})\cdot(28.317\text{L/ft}^3)}{568{,}755\text{L}}\right)} = 1{,}249{,}985\,\frac{\text{pCi}}{\text{L}}$$

As it is uncertain which vessel will be mined first, parametric analysis using EQNs 29 and 28 result in the generation of Table 17. Supporting data is extracted from Table 16 and Assumption 14.

Table 17: Phase 3 Parametric Analysis

Q, Gas Flows (ft^3/min)							Gas Conc. (pCi ^{222}Rn/L)	
FWTF	TTA 1A	TTA 1B	TTA 2A	TTA 2B	Sum	Mining	Chiller $C_{t,in}$	Carbon Beds C_{out}
500	125	125	125	125	1,000	None	315,687	3,430.5
500	**125**	**125**	**125**	**125**	**1,000**	**TTA 1A**	**565,009**	**6,139.8**
500	**125**	**125**	**125**	**125**	**1,000**	**TTA 1B**	**565,009**	**6,139.8**
500	125	125	125	125	1,000	TTA 2A	453,154	4,924.3
500	125	125	125	125	1,000	TTA 2B	453,154	4,924.3
500	125	125	125	0	875	TTA 2A	496,426	2,788.8
500	125	0	125	125	875	TTA 1A	606,796	3,408.9
500	125	0	0	125	750	TTA 1A	682,888	1,591.8
500	125	0	0	0	625	TTA 1A	789,416	537.0
500	0	125	125	125	875	TTA 2A	478,962	2,690.7
500	0	0	125	0	625	TTA 2A	585,997	398.6
500	0	0	0	0	500	None	420,000	45.0

The variance of flow rates and mining activities indicate that the peak concentrations of Table 17 are when only TTA 1A or 1B remains and is being mined. However, in terms of consequence down stream, the highest consequence is seen if all TTA tanks remain and either TTA 1A or 1B is being mined. This is due to treatment efficiency degradation at higher flow rates. Therefore, this highest consequence case is chosen as most conservative (C_{out} = 6,140 pCi/L).

6. Summary of ^{222}Rn Source and Concentration Calculations

Gas stream rates and concentrations are collected in Table 18. Carbon Bed effluents are collected in Table 19.

Table 18: Gas Stream Rates and Concentrations

Vessel	Silo 1	Silo 2	TTA 1A	TTA 1B	TTA 2A	TTA 2B	FWTF	Sum
Phase	Gas Stream Rates (ft^3/min)							
1	250	250	0	0	0	0	0	500
2A	250	250	125	125	0	0	0	750
2B	0	250	125	125	125	125	0	750
2C	0	0	125	125	125	125	0	500
3	0	0	125	125	125	125	500	1,000
Phase	Gas Stream ^{222}Rn (pCi/L)							
1	252,173	249,598	0	0	0	0	0	250,885
2A	1,665,166	250,092	272,500	272,500	0	0	0	729,253
2B	0	912,497	272,500	272,500	150,246	150,246	0	445,081

Table 18: Gas Stream Rates and Concentrations

Vessel	Silo 1	Silo 2	TTA 1A	TTA 1B	TTA 2A	TTA 2B	FWTF	Sum
2C	0	0	272,500	272,500	150,246	150,246	0	211,373
3	0	0	2,267,082	272,500	150,246	150,246	420,000	565,009

Table 19: Carbon Bed Effluents

Phase	Q_{out} (ft^3/min)	C_{out} (pCi ^{222}Rn/L)
1	454.13	26.91
2A	681.19	1,699.85
2B	681.19	1,037.46
2C	454.13	22.67
3	908.25	6,139.77

Table 18 and 19 values may increase slightly as a function of recycle in spreadsheet application. Table 18 values provide kernels for the recycle. However, as the effluents from the carbon beds do not exceed approximately 1% of the inlet, even complete recycle will result in less than 1% growth.

C. Condensate ^{222}Rn Concentrations

Sections V.A.2 and V.A.3 provide for calculation of the quantity and activity of condensates from the chiller. Given the continuous nature of collection, short half-life of ^{222}Rn, and the (See Assumption 6) time of aggregation and decay, the majority of the radon will have decayed at the time of discharge.

During the time of collection, the rate of change of ^{222}Rn in the condensate is:

$$dA = (Q_{COND} \cdot C_{COND})dt - \lambda A dt \qquad \textbf{(EQN 30)}$$

Integrating this equation over t = 0 to t_1 with the boundary condition that A = 0 at t = 0,

$$A_{t_1} = \frac{Q_{COND} \cdot C_{COND}}{\lambda} - e^{-\left(\lambda t_1 - \ln\left(\frac{Q_{COND} \cdot C_{COND}}{\lambda}\right)\right)} \qquad \textbf{(EQN 31)}$$

where:

t_1 = End of condensate collection interval, hr
A_{t1} = Activity in condensate collected by time t_1, pCi
Q_{COND} = Condensate collection rate, L/hr
C_{COND} = Condensate activity at collection, pCi/L
λ = ^{222}Rn decay constant, 7.5536E-3/hr

Following the period of condensate collection, the collected activity will simply decay until the condensate is discharged such that

$$A_{t2} = A_{t1} \cdot e^{-\lambda(t_2 - t_1)} = \left(\frac{Q_{COND} \cdot C_{COND}}{\lambda} - e^{\left(\lambda t_1 - \ln\left(\frac{Q_{COND} \cdot C_{COND}}{\lambda}\right)\right)} \right) \cdot e^{-\lambda(t_2 - t_1)}$$

(EQN 32)

As EQN 32 is linear with respect to the product ($Q_{COND} \cdot C_{COND}$) one may assume a unit value for this product (1 pCi/hr) whereupon the activity is a simple product. For Assumption 6 durations of t_1 = 20 days (480 hours) and t_2 = 35 days (840 hours), the activity in the collected condensate at the time of discharge is:

$$A_d = 8.4948\,\text{hr} \cdot \left(Q_{COND} \cdot C_{COND} \frac{\text{pCi}}{\text{hr}} \right) [=]\ \text{pCi} \qquad \textbf{(EQN 33)}$$

where:

A_d = ^{222}Rn activity in discharged condensate, pCi

The meaning of EQN 33 is that over the 20 days of collection of unit ^{222}Rn activities and 15 days of decay, 8.4948 units of ^{222}Rn activity remain to be discharged with the collected condensate.

The decayed activity of the condensate is evaluated using EQNs 8 and 9 => QCOND; EQN 10 => C_{COND} (as collected); Q is total Q_{COND} over 20 days (See Assumption 6); EQN 33 => A_d. The concentration $C_{Discharge} = A_d/Q$. The results of these calculations, using Table 4 and Table 18 input are provided in Table 20.

Table 20: Discharge Condensate ^{222}Rn Concentration

Phase	$\bar{Q}_{in}$ (ft^3/min)	C_{in} (pCi/L)	Q_{Cond} (L/min)	C_{Cond} (pCi/L)	A_d (pCi)	Q (L)	$C_{Discharge}$ (pCi/L)
1	500	250,885	0.2950	138,031	2.076E+07	8,497	2,442.8
2A	750	729,253	0.4425	401,216	9.049E+07	12,745	7,100.5
2B	750	445,081	0.4425	244,872	5.523E+07	12,745	4,333.6
2C	500	211,373	0.2950	116,292	1.749E+07	8,497	2,058.1
3	1,000	565,009	0.5900	310,854	9.348E+07	16,993	5,501.3

<u>Check Calculation of ^{222}Rn Equilibrium Coefficient</u>

Reference 7 provides the Henry's Law coefficient (K) of ^{222}Rn as 2,260 atm.

Basis: 1 Ci ^{222}Rn/L in the gas

$$SpA = \frac{\ln(2)}{t_{1/2}} \cdot \frac{N_{Avg}}{MW} \cdot \frac{\text{Ci} \cdot \text{s}}{3.7\text{E}10\text{dis}} = 153{,}841.7 \frac{\text{Ci}}{\text{g}}$$

Gas Phase Pressure:

$$P = \frac{1\text{Ci}}{\text{L}} \cdot \frac{\text{g}}{153{,}841.7\text{Ci}} \cdot \frac{\text{mol}}{222\text{g}} \cdot \frac{22.4\text{L}\cdot\text{atm}}{\text{mol}} = 6.558747\text{E}-7\,\text{atm}$$

Henry's Law: $P = K\,X$ (X = liquid phase concentration)

$$\therefore X = \frac{6.558747\text{E}-7\,\text{atm}}{2260\,\text{atm}} = 2.9021\text{E}-10 = \frac{\text{n (atoms) solute}}{\text{n (molecule) solvent}}$$

For 1 liter of water:

$$\text{n (molecule) solvent} = 1\text{L} \cdot \frac{1000\text{g}}{\text{L}} \cdot \frac{\text{mol}}{18.0152\text{g}} \cdot \frac{6.02252\text{E23 molecule}}{\text{mol}} = 3.343021\text{E25 molecules}$$

$$n^{222Rn} = X \cdot \text{n (molecule) solvent} = (2.9021\text{E}-10)\cdot(3.343021\text{E25}) = 9.7101784\text{E15 atoms}$$

$$\therefore \frac{\text{Ci}^{222}\text{Rn/L water}}{\text{Ci}^{222}\text{Rn/L air}} = \frac{9.7101784\text{E15 atoms}}{\text{L}} \cdot \frac{\text{mol}}{6.02252\text{E23 atoms}} \cdot \frac{222\text{g}}{\text{mol}} \cdot \frac{153{,}841.7\text{Ci}}{\text{g}} = 0.5501744$$

D. Consequences of ^{222}Rn Stack Emissions

Evaluations of this section are intended to provide the transforms necessary to evaluate process releases of ^{222}Rn in relation to stated limits described in Table 1.

1. General Exposure Evaluation

The consequences of ^{222}Rn stack release from the RCS is a function of the:

- Activity and flow rate from the RCS to the stack,
- Building ventilation entering the stack,
- Height and exit diameter of the stack, and
- Gaseous dispersion.

The total stack flow rate is:

$$Q_{stack} = Q_{bld} + Q_{RCS}\ [=]\ \frac{\text{m}^3}{\text{s}} \qquad \textbf{(EQN 34)}$$

Where:

Q_{stack} = Stack effluent rate, m^3/s
Q_{bld} = Building ventilation rate, m^3/s
Q_{RCS} = RCS discharge to the stack, m^3/s

Under most conditions of operation, Q_{RCS} is a fraction of the gas leaving the carbon beds as that flow, and its ^{222}Rn concentration, will be modified by makeup air and return of air to the silos or TTA vessels.

As the active vessels and equipment are operated under partial vacuum, the building gas radon concentration may be neglected and the stack ^{222}Rn concentration expressed as:

$$C_{stack} = \frac{C_{RCS} \cdot Q_{RCS}}{Q_{stack}} [=] \frac{pCi}{m^3} \qquad \text{(EQN 35)}$$

The ^{222}Rn atmospheric concentration at a point of exposure is:

$$C_{atm} = C_{stack} \cdot Q_{stack} \cdot \chi/Q \; [=] \; \frac{pCi}{m^3} \qquad \text{(EQN 36)}$$

Where:

C_{atm} = Atmospheric concentration at a given point, pCi/m^3

χ/Q = Atmospheric dispersion coefficient for a specified weather condition, distance, and direction, s/m^3

With the determination of appropriate χ/Q values, atmospheric concentrations at points of exposure may be evaluated and compared to limits of Table 1.

2. Definition of Limits

As defined in Table 1, the off-site exposure limit is 0.5 pCi ^{222}Rn/L at a range of 350 m. On-site exposure limits are in terms of "Working Levels" (WL). Reference 11 provides that:

> *Working Level (WL) is any combination of short-lived radon daughters (for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214...) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.*

To appropriately describe WL units to a comparison of EQN 36 results, WL must be converted to an equivalent expression of ^{222}Rn concentration.

Application of the WL definition was presaged within Reference 12 to describe that the worker exposure hazard primarily lies in the concentration of the radon daughters in the air, rather than simply of the radon, because of inhalation and body uptake of the solid daughters. As described in Reference 12, and because of gaseous filtration in the RCS, a filtered gas stream is no longer in equilibrium between ^{222}Rn and its daughters. By Assumption 19, the daughters can be considered negligible following treatment and one must determine the activity of the daughters at the time of exposure due to their ingrowth.

Applying the commercial program RADDECAY (Grove Engineering, Reference 13) to a chosen unit release of 1 Ci of ^{222}Rn with a decay time of 200 seconds (Assumption 17, distance/velocity), the daughter alpha energy attributed by such a release may be determined as in Table 21.

Table 21: Daughter Alpha Energy Per Initial Ci ^{222}Rn (200s decay)

Unit	Isotope						Ref.
	^{222}Rn	^{218}Po	^{214}Pb	^{214}Bi	^{214}Po	Total	
Ci at t=200s	0.99958	0.53106	0.024985	0.0010026	0.0010024		13
SpA (Ci/g)	1.54E+05	2.83E+08	3.28E+07	4.46E+07	3.21E+14		3
MW	222	218	214	214	214		3
g	6.50E-06	1.88E-09	7.62E-10	2.25E-11	3.12E-18		
atoms	1.76E+16	5.19E+12	2.14E+12	6.33E+10	8.78E+03		
Daughter Alpha (MeV/atom)		13.6898014	7.689801	7.688462	7.688462		14
Daughter Alpha (MeV/Ci ^{222}Rn Initial)		7.10E+13	1.65E+13	4.86E+11	6.75E+04	8.80E+13	

As developed in Table 21, with regard to Reference 11, a gas stream with a concentration of 1 Ci ^{222}Rn/L at release (and at the release point) will result in a 200 s alpha potential of:

$$WL = \frac{\alpha(\text{MeV/Ci/L Initial})}{1.3\text{E5 MeV/WL}} = \frac{8.8\text{E13}}{1.3\text{E5}} = \frac{6.769\text{E8 WL}}{\text{Ci }^{222}\text{Rn Initial/L}} \qquad \textbf{(EQN 37)}$$

The atmospheric concentrations corresponding to the WL limits of Table 1 may be derived as:

$$C_{atm,0.2WL} = \frac{0.2\,WL}{\left(\dfrac{6.769\text{E8 WL}}{\text{Ci }^{222}\text{Rn Initial/L}}\right)} \cdot \frac{10^{12}\text{pCi}}{\text{Ci}} = 295.5\,\frac{\text{pCi}}{\text{L}} \qquad \textbf{(EQN 38)}$$

and

$$C_{atm,0.02WL} = \frac{0.02\,WL}{\left(\dfrac{6.769\text{E8 WL}}{\text{Ci }^{222}\text{Rn Initial/L}}\right)} \cdot \frac{10^{12}\text{pCi}}{\text{Ci}} = 29.55\,\frac{\text{pCi}}{\text{L}} \qquad \textbf{(EQN 39)}$$

With these transformations, Table 1 values may be expressed as represented in Table 22.

Table 22: Ambient Air Limitations		
Location	Distance (m)	Limit
Off-Site	350	0.5 pCi ^{222}Rn/L
On-Site	100	295.5 pCi ^{222}Rn/L, instantaneous
On-Site	100	29.55 pCi ^{222}Rn/L, weekly average

3. On-Site Dispersion Coefficients

On-site consequences and compliance with the limits of Table 22 require that χ/Q values be developed for application in EQN 34. The atmospheric conditions for instantaneous exposure limits (See Assumption 17) for this analysis are those of an inversion engendered fumigation (Pasquille Class G – very stable).

Reference 15 provides χ/Q for fumigation as:

$$\chi/Q = \frac{EXP\left[\frac{-y^2}{2\sigma_{y,G}^2}\right]}{(2\pi)^{1/2} \cdot H\,\sigma_{y,G} \cdot \bar{u}} \quad [=] \quad \frac{s}{m^3} \qquad \textbf{(EQN 40)}$$

Where:

y	=	crosswind distance, y = 0 at center of plume, m
$\sigma_{y,G}$	=	Horizontal dispersion parameter, Class G, m
H	=	Height of inversion lid, m
u	=	mean inverse wind speed, m/s

Table 11.3.3 of Reference 15 provides that $\sigma_{y,G} \approx 2/3\ \sigma_{y,F}$. Figure 11.3-3 (See Ref. 15) provides $\sigma_{y,F}$ versus distance, wherein $\sigma_{y,F}$ (100m) = 4m. Thus,

$$\sigma_{y,G} = \frac{2}{3}\sigma_{y,F} = \frac{2}{3}(4m) = \frac{8}{3}m \qquad \textbf{(EQN 41)}$$

Substituting y = 0, u = 0.5 m/s, and H = 200 ft (See Assumption 17) and $\sigma_{y,G}$ into EQN 40:

$$\chi/Q_{Onsite,inst.} = \frac{EXP\left[\frac{-(0)^2}{2\left(8/3\right)^2}\right]}{(2\pi)^{1/2} \cdot \left(200ft \cdot \frac{0.3048m}{ft}\right)\left(8/3\,m\right)\left(\frac{0.5m}{s}\right)} = 4.9082sE-03\frac{s}{m^3}$$

This result may be applied before establishment of actual gas rates and concentrations to determine allowed release rates by reforming EQN 36 as:

$$C_{stack} \cdot Q_{stack} = \frac{C_{atm}\left(\frac{pCi}{L}\right)}{\chi/Q\left(\frac{s}{m^3}\right)\cdot\left(\frac{m^3}{1000L}\right)} \; [=] \; \frac{pCi}{s} \qquad \text{(EQN 42)}$$

Application of EQN 42 for instantaneous release and on-site exposure limits yields:

$$\left(C_{stack} \cdot Q_{stack}\right)_{0.2WL} = 6.020s\,E7\,pCi/s$$

Weekly average limits for on-site workers may be established based upon a χ/Q applicable to such exposure. For the purposes of weekly average exposures, the atmospheric conditions for this analysis are those of a sTable meteorology (Pasquille Class F).

Reference 16 (Screen3 model) provides the capability to evaluate low-level hourly exposure to contaminants released to the atmosphere. Application of the Screen3 model (see Ref. 16) with the input parameters of Table 23 results in a hourly χ/Q of :

$$\chi/Q_{On-site\,hourly} = \frac{54.89\frac{\mu g}{m^3}}{1\frac{g}{s}\cdot 10^6\frac{\mu g}{g}} = 5.489E-05\frac{s}{m^3} \qquad \text{(EQN 43)}$$

Table 23: Silos 1 & 2 AWR Screen3 Model Inputs

Simple Terrain Inputs	Input Value
Source Type	Point
Emission Rate (g/s)	1.000
Stack Height (m)	45.72
Stack Inside Diameter (m)	0.6096
Stack Exit Velocity (m/s)	1.6170
Stack Gas Exit Temperature (K)	293.0
Ambient Air Temperature (K)	293.0
Receptor Height (m)	0.0000
Urbal/Rural Option	Rural
Building Height (m)	18.29
Minimum Horizontal Building Dimension (m)	48.77
Maximum Horizontal Building Dimension (m)	48.77

To consider weekly averaged exposures, one must adjust the hourly dispersion factor to address the site meteorological joint frequency distribution. Equations D and H of Table 11.3.1.1 (see Ref. 15) provide instantaneous and long-term sector-averaged expressions of χ/Q from elevated sources. The ratio of these equations provides a factor to account for the varying wind conditions as:

$$\frac{\chi/Q_{Long-term,sector-avg}}{\chi/Q_{Instantaneous}} = \sqrt{\frac{2}{\pi}} \cdot \sigma_{y,F} \cdot \frac{0.01f}{2\left(x/n\right)} = 0.03064 \qquad \text{(EQN 44)}$$

Where:

f	=	sector frequency, maximum = 12% (see Ref. 1e)
x	=	distance, 100 m
n	=	wind sectors (16)

The appropriate weekly χ/Q for weekly average exposures may be evaluated from EQNs 43 and 44 as:

$$\chi/Q_{Onsite,weekly} = \chi/Q_{hourly} \cdot 0.03064 = 1.682E-06 \frac{s}{m^3} \qquad \text{(EQN 45)}$$

Application of EQN 42 for weekly average release and on-site exposure limits yields:

$$\left(C_{stack} \cdot Q_{stack}\right)_{0.02WL} = 1.757E+09 \text{ pCi/s}$$

This section's results are applied to design basis gas streams in §V.D.5, below.

4. Off-Site Dispersion Coefficients

Reference 17 (CAP88-PC model) provides the capability to evaluate low-level chronic exposure to radionuclides released to the atmosphere.

Application of CAP88-PC for the Fernald Silos AWR Project with the Table 24 inputs results in a matrix of χ/Q values for varied directions and distances provided in Table 25.

From Table 25, the greatest χ/Q is chosen to represent the direction and distance of the greatest off-site dose consequence. Thus, χ/Q for off-site application in EQN 36 is $\chi/Q_{off\text{-}site}$ = 5.020 E-07 s/m^3.

Table 24: CAP88-PC Inputs	
Run Options	Individual type; create χ/Q table
Met. Data	Wind File 93814 (Covington, Greater Cincinnati)
Source Data	Stack, 45.72 m (150 ft); 0.93 m (3 ft) diameter; momentum plume rise at 6.18 m/s (~8,600 ft^3/min)
Agri. Data	Rural, default
Nuclide Data	Rn-222, 1 Ci/yr

Table 25: Off-Site CAP88-PC χ/Q Results (s/m^3)

Dir	Distance (meters)					
	250	350	500	700	750	1500
N	2.253E-07	3.019E-07	3.831E-07	4.453E-07	4.507E-07	3.352E-07
NNW	1.430E-07	1.768E-07	1.961E-07	2.054E-07	2.047E-07	1.412E-07
NW	1.108E-07	1.394E-07	1.575E-07	1.663E-07	1.660E-07	1.147E-07
WNW	1.379E-07	1.740E-07	1.913E-07	1.963E-07	1.947E-07	1.303E-07
W	2.512E-07	3.092E-07	3.312E-07	3.325E-07	3.289E-07	2.162E-07
WSW	1.641E-07	2.066E-07	2.221E-07	2.203E-07	2.172E-07	1.393E-07
SW	1.665E-07	1.989E-07	2.134E-07	2.182E-07	2.165E-07	1.434E-07
SSW	1.363E-07	1.701E-07	1.907E-07	2.009E-07	2.001E-07	1.351E-07
S	2.156E-07	2.832E-07	3.433E-07	3.830E-07	3.847E-07	2.708E-07
SSE	1.348E-07	1.650E-07	1.866E-07	1.976E-07	1.968E-07	1.313E-07
SE	1.282E-07	1.660E-07	2.072E-07	2.364E-07	2.377E-07	1.647E-07
ESE	1.737E-07	2.248E-07	2.808E-07	3.180E-07	3.191E-07	2.151E-07
E	2.577E-07	3.414E-07	4.224E-07	4.724E-07	4.734E-07	3.208E-07
ENE	2.009E-07	2.666E-07	3.149E-07	3.375E-07	3.363E-07	2.255E-07
NE	2.391E-07	3.541E-07	4.508E-07	5.010E-07	**5.020E-07**	3.503E-07
NNE	2.088E-07	2.961E-07	3.913E-07	4.619E-07	4.681E-07	3.530E-07
Max	2.577E-07	3.541E-07	4.508E-07	5.010E-07	**5.020E-07**	3.530E-07
Max. Dir.	NNE	NE	NE	NE	NE	NNE

5. Design Basis Emission Consequences

Assumption 5 provides that building ventilation will be 8100 ft^3/min. Design choice of makeup air supply places the makeup air entry into the treated gas stream before diversion to the TTA/silos or stack. This configuration is in contradiction to Assumption 9. However, calculations of §V.A.5 demonstrate the recirculation of treated gas may be neglected in hand calculation of TTA discharge gas. In spreads based calculations, the recycle may be easily implemented with the results for all phases of operation provided in §V.E., below. Using this recycle, the developments of §§V.A–V.C, above, and selection of RCS bleeds to the stack provide input to Table 26 (C_{RCS}, Q_{RCS}, Q_{stack}, C_{stack}). Application of EQNs 34, 35, and 36 yield the results of Table 26.

Table 26 C_{RCS} values are seen to be lower than those of Table 19. These reductions are because of the placement and selection of makeup air rates.

Table 26: Silos 1 & 2 AWR Design Basis Exposure, ^{222}Rn

Exposure Basis					On-Site (instant.)	On-Site (weekly avg.)	Off-Site
Limit (pCi ^{222}Rn/L)					295.5	29.55	0.5
χ/Q (s/m^3)					4.91E-03	1.68E-06	5.020E-07
RCS Phase	C_{RCS} (pCi/L)	Q_{RCS} (ft^3/min)	Q_{stack} (ft^3/min)	C_{stack} (pCi/L)	C_{atm} (pCi/L)		
1	24.08	50	8,150	0.15	0.003	9.56E-07	2.85E-07
2A	1,701.04	454	8,554	90.31	1.789	6.13E-04	1.83E-04
2B	1,037.46	681	8,781	80.48	1.637	5.61E-04	1.67E-04
2C	22.67	454	8,554	1.20	0.024	8.17E-06	2.44E-06
3	6,139.77	908	9,009	619.01	12.917	4.43E-03	1.32E-03

Table 26 results and limits demonstrate compliance with allowable emissions of ^{222}Rn regarding worker and public exposure.

E. Design Selections and Calculation Implementation

Tables 27a-31c (a, b, and c for each phase), below provide the material balances for the RCS operations across all phases of normal operation. Calculations are conducted in accordance with the development provided in this analysis. Where gas streams are being recycled, some values of concentrations will be notable to the reviewer as differing from specific values calculated above; such deviation is because of the recycling component accounted within the interative recycle calculations and heat supplied to the air by the fan at 10 hp (Break Horse Power basis) per 1000 ft^3/min. Stream numbers on Tables 27a-31c are those of process flow diagrams associated with the RCS and associated HVAC contributions (see Ref.s 18 and 19).

PHASE 1

Table 27a: Phase 1 RCS Material Balance

STREAM NUMBER	1	2	3	4	5	6	6a
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)
AIR (LBS/HR)	1,080	1,080	0	2,161	2,161	2,161	3,153
WATER (LBS/HR)	20.3	20.3	0	41	1.7	1.7	8
TOTAL, (LBS/HR)	1,100.7	1,100.7	0	2,201	2,162	2,162	3,160
FLOW (CFM)	250	250	0	500	454	454	678
FLOW (GPM)							
RADON (PICOCURIES/L)	252,195	249,620	0	250,907	276,250	27	24
RADON (CURIES/HR)	0.107	0.106	0	0.213	0.213	0.0000208	0.0000278
TEMPERATURE (DEG F)	75	75	75	75	40	40	73.3
PRESSURE (INCHES WC)	-0.1	-0.1	-0.1	-0.1			
NOTES	RELATIVE HUMIDITY=100%. RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100%. RADON CONCENTRATION STEADY STATE	TTA NOT FUNCTIONAL IN PHASE 1	FLOW REPRESENTS SILOS 1 AND 2	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AI INCL. FAN HEAT

PHASE 1

Table 27b: Phase 1 RCS Material Balance

STREAM NUMBER	7	8	9	9A	10	11	12
COMPONENT	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK
AIR (LBS/HR)	1,011	1,011	0	0		0	223
WATER (LBS/HR)	2.5	2.5	0	0	39.0	0	0.5
TOTAL, (LBS/HR)	1,013.2	1,013.2	0	0	39.0	0	223.1
FLOW (CFM)	227	227	0	0		0	50.0
FLOW (GPM)					0.08		
RADON (PICOCURIES/L)	24	24	0	0	138,043	0	24
RADON (CURIES/HR)	0.0000093	0.0000093	0	0	0.00000244	0	0.00000205
TEMPERATURE (DEG F)	73.3	73.3	75	73.3	40	75	73.3
PRESSURE (INCHES WC)							
NOTES			TTA NOT FUNCTIONAL IN PHASE 1	TTA NOT FUNCTIONAL IN PHASE 1		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 1	RELATIVE HUMIDITY=14.2 %

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT Fernald Silos 1 & 2 AWR				SUBJECT RCS Performance		
REV #	0					SHEET 35 of 42
BY & DATE		12/16/99				PROJ. NO FSC-624
CHKD & DATE						CALC. NO. CA-FSC624-FM-001

PHASE 1

Table 27c: Phase 1 RCS Material Balance

STREAM NUMBER	13	14	15	16	17	18	19	20
COMPONENT	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	35,004	35,226	761	231		0	0	0
WATER (LBS/HR)	659.1	660	1.9	4.4	25,037	0	0	0
TOTAL (LBS/HR)	35,663	35,886	762	235.6	25,037	0	0	0
FLOW (CFM)	8,100	8,150	171	53.5		0	0	0
FLOW (GPM)					50			
RADON (PICOCURIES/L)	0	0.148	24	0	2,443	0	0	0
RADON (CURIES/HR)	0	0.00000205	0.0000070	0	0.0000208	0	0	0
TEMPERATURE (DEG F)	75	75.0	73.3	75		75	75	75
PRESSURE (INCHES WC)								
NOTES		RELATIVE HUMIDITY=99.5%	FLOW ENTERS FAN SUCTION AFTER CARBON BEDS		INTERMITTENT FLOW; DECAYED BY STORAGE	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1

PHASE 2A

Table 28a: Phase 2A RCS Material Balance

STREAM NUMBER	1	2	3	4	5	6	6a
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)
AIR (LBS/HR)	1,080	1,080	1,080	3,241	3,241	3,241	4,667
WATER (LBS/HR)	20.3	20.3	20.3	61	2.5	2.5	3
TOTAL (LBS/HR)	1,100.7	1,100.7	1,100.7	3,302	3,244	3,244	4,670
FLOW (CFM)	250	250	250	750	681	681	1,000
FLOW (GPM)							
RADON (PICOCURIES/L)	1,665,166	251,637	272,500	729,768	803,477	1,701	1,701
RADON (CURIES/HR)	0.707	0.107	0.116	0.930	0.930	0.00197	0.00289
TEMPERATURE (DEG F)	75	75	75	75	40	40	72.7
PRESSURE (INCHES WC)	-0.1	-0.1	-0.1	-0.1			
NOTES	RELATIVE HUMIDITY=100%. RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100%. RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100%. RADON CONCENTRATION STEADY STATE	FLOW REPRESENTS SILOS 1 AND 2 PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT Fernald Silos 1 & 2 AWR				SUBJECT RCS Performance		
REV #	0					SHEET 36 of 42
BY & DATE	12/16/99					PROJ. NO FSC-624
CHKD & DATE						CALC. NO. CA-FSC624-FM-001

PHASE 2A

Table 28b: Phase 2A RCS Material Balance

STREAM NUMBER	7	8	9	9A	10	11	12
COMPONENT	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK
AIR (LBS/HR)	0	1,016	1,080	0		0	2,031
WATER (LBS/HR)	0	0.7	20.3	0	58.5	0	1.4
TOTAL, (LBS/HR)	0	1,016.2	1,100.7	0	58.5	0	2,032
FLOW (CFM)	0	227	250	0		0	454
FLOW (GPM)					0.12		
RADON (PICOCURIES/L)	0	1,701	0	0	401,500	0	1,701
RADON (CURIES/HR)	0	0.000656	0	0	0.0000107	0	0.00131
TEMPERATURE (DEG F)	72.7	72.7	75	72.7	40	75	72.7
PRESSURE (INCHES WC)							
NOTES	NO RECYCLE FLOW TO SILO1 IN PHASE 2A		NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUAL TO STREAM 8 DURING RECIRC OF TTA		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 2	RELATIVE HUMIDITY=4.4 %

PHASE 2A

Table 28c: Phase 2A RCS Material Balance

STREAM NUMBER	13	14	15	16	17	18	19	20
COMPONENT	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	35,004	37,035	1,426	0		360	360	360
WATER (LBS/HR)	659.1	660	1.0	0	25,037	6.8	6.8	6.8
TOTAL, (LBS/HR)	35,663	37,695	1,427	0	25,037	366.9	366.9	366.9
FLOW (CFM)	8,100	8,554	319	0		83	83	83
FLOW (GPM)					50			
RADON (PICOCURIES/L)	0	90.3	1,701	0	7,106	0	0	0
RADON (CURIES/HR)	0	0.00131	0.00092	0	0.0000807	0	0	0
TEMPERATURE (DEG F)	75	74.9	72.7	75		75	75	75
PRESSURE (INCHES WC)								
NOTES		RELATIVE HUMIDITY=95 .1%			INTERMITTENT FLOW: DECAYED BY STORAGE	SILO 1	SILO 1	SILO 1

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT Fernald Silos 1 & 2 AWR				SUBJECT RCS Performance			
REV #	0					SHEET 37 of 42	
BY & DATE		12/16/99				PROJ. NO	FSC-624
CHKD & DATE						CALC. NO.	CA-FSC624-FM-001

PHASE 2B

Table 29a: Phase 2B RCS Material Balance

STREAM NUMBER	1	2	3	4	5	6	6a
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)
AIR (LBS/HR)	0	1,080	2,161	3,241	3,241	3,241	4,667
WATER (LBS/HR)	0	20.3	40.7	61	2.5	2.5	3
TOTAL (LBS/HR)	0	1,100.7	2,201.4	3,302	3,244	3,244	4,670
FLOW (CFM)	0	250	500	750	681	681	1,000
FLOW (GPM)							
RADON (PICOCURIES/L)	0	912,497	211,373	445,081	490,036	1,037	1,037
RADON (CURIES/HR)	0	0.388	0.180	0.567	0.567	0.00120	0.00176
TEMPERATURE (DEG F)	75	75	75	75	40	40	72.7
PRESSURE (INCHES WC)	-0.1	-0.1	-0.1	-0.1			
NOTES	NO FLOW FROM SILO 1 IN PHASE 2B	RELATIVE HUMIDITY =100%. RADON CONCENT RATION STEADY STATE	RELATIVE HUMIDITY= 100%. RADON CONCENTR ATION: STEADY STATE	FLOW REPRESENTS SILOS 1 AND 2 PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT

PHASE 2B

Table 29b: Phase 2B RCS Material Balance

STREAM NUMBER	7	8	9	9A	10	11	12
COMPONENT	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK
AIR (LBS/HR)	0	0	2,161	0		0	3,047
WATER (LBS/HR)	0	0	40.7	0	58.5	0	2.0
TOTAL (LBS/HR)	0	0	2,201.4	0	58.5	0	3,049
FLOW (CFM)	0	0	500	0		0	681
FLOW (GPM)					0.12		
RADON (PICOCURIES/L)	0	0	0	0	244,872	0	1,037
RADON (CURIES/HR)	0	0	0	0	0.0000065	0	0.00120
TEMPERATURE (DEG F)	72.7	72.7	75	72.7	40	75	72.7
PRESSURE (INCHES WC)							
NOTES	NO RECYCLE FLOW TO SILOS IN PHASE 2B	NO RECYCLE FLOW TO SILOS IN PHASE 2B	NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 2B	RELATIVE HUMIDITY=4.4 %

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT Fernald Silos 1 & 2 AWR				SUBJECT RCS Performance		
REV #	0					SHEET 38 of 42
BY & DATE		12/16/99				PROJ. NO FSC-624
CHKD & DATE						CALC. NO. CA-FSC624-FM-001

PHASE 2B

Table 29c: Phase 2B RCS Material Balance

STREAM NUMBER	13	14	15	16	17	18	19	20
COMPONENT	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	35,004	38,050	1,426	0		360	360	360
WATER (LBS/HR)	659.1	661	1.0	0	25,037	6.8	6.8	6.8
TOTAL (LBS/HR)	35,663	38,712	1,427	0	25,037	366.9	366.9	366.9
FLOW (CFM)	8,100	8,781	319	0		83	83	83
FLOW (GPM)					50			
RADON (PICOCURIES/L)	0	80.5	1,037	0	4,334	0	0	0
RADON (CURIES/HR)	0	0.00120	0.000562	0	0.0000492	0	0	0
TEMPERATURE (DEG F)	75	74.8	72.7	75		75	75	75
PRESSURE (INCHES WC)								
NOTES		RELATIVE HUMIDITY=92.8%			INTERMITTENT FLOW: DECAYED BY STORAGE	SILO 2	SILO 2	SILO 2

PHASE 2C

Table 30a: Phase 2C RCS Material Balance

STREAM NUMBER	1	2	3	4	5	6	6a
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)
AIR (LBS/HR)	0	0	2,161	2,161	2,161	2,161	3,147
WATER (LBS/HR)	0	0	40.7	41	1.7	1.7	2
TOTAL (LBS/HR)	0	0	2,201.4	2,201	2,162	2,162	3,149
FLOW (CFM)	0	0	500	500	454	454	675
FLOW (GPM)							
RADON (PICOCURIES/L)	0	0	211,373	211,373	232,723	23	23
RADON (CURIES/HR)	0	0	0.180	0.180	0.180	0.0000175	0.0000260
TEMPERATURE (DEG F)	75	75	75	75	40	40	73.1
PRESSURE (INCHES WC)	-0.1	-0.1	-0.1	-0.1			
NOTES	NO FLOW FROM SILO IN PHASE 2C	NO FLOW FROM SILO IN PHASE 2C		FLOW REPRESENTS WTA PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROJECT Fernald Silos 1 & 2 AWR					SUBJECT RCS Performance		
REV #	0						SHEET 39 of 42
BY & DATE		12/16/99					PROJ. NO FSC-624
CHKD & DATE							CALC. NO. CA-FSC624-FM-001

PHASE 2C

Table 30b: Phase 2C RCS Material Balance

STREAM NUMBER	7	8	9	9A	10	11	12
COMPONENT	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK
AIR (LBS/HR)	0	0	2,161	0		0	2,027
WATER (LBS/HR)	0	0	40.7	0	39.0	0	1.4
TOTAL, (LBS/HR)	0	0	2,201.4	0	39.0	0	2,029
FLOW (CFM)	0	0	500	0		0	454
FLOW (GPM)					0.08		
RADON (PICOCURIES/L)	0	0	0	0	116,292	0	23
RADON (CURIES/HR)	0	0	0	0	0.00000206	0	0.0000175
TEMPERATURE (DEG F)	73.1	73.1	75	73.1	40	75	73.1
PRESSURE (INCHES WC)							
NOTES	NO FLOW TO SILOS IN PHASE 2C	NO FLOW TO SILOS IN PHASE 2C	NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA		FUTURE WASTE TREATMENT NOT FUNCTIONAL IN PHASE 2C	RELATIVE HUMIDITY=4.4 %

PHASE 2C

Table 30c: Phase 2C RCS Material Balance

STREAM NUMBER	13	14	15	16	17	18	19	20
COMPONENT	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	35,004	37,031	986	0		0	0	0
WATER (LBS/HR)	659.1	660	0.7	0	25,037	0	0	0
TOTAL, (LBS/HR)	35,663	37,691	987	0	25,037	0	0	0
FLOW (CFM)	8,100	8,554	221	0		0	0	0
FLOW (GPM)					50			
RADON (PICOCURIES/L)	0	1.20	23	0	2,058	0	0	0
RADON (CURIES/HR)	0	0.0000175	0.0000085	0	0.0000175	0	0	0
TEMPERATURE (DEG F)	75	74.9	73.1	75		75	75	75
PRESSURE (INCHES WC)								
NOTES		RELATIVE HUMIDITY=95 .1%			INTERMITTENT FLOW: DECAYED BY STORAGE	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C

PHASE 3

Table 31a: Phase 3 RCS Material Balance

STREAM NUMBER	1	2	3	4	5	6	6a
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)
AIR (LBS/HR)	0	0	2,161	4,321	4,321	4,321	4,321
WATER (LBS/HR)	0	0	40.7	81	3.3	3.3	3
TOTAL (LBS/HR)	0	0	2,201.4	4,403	4,325	4,325	4,325
FLOW (CFM)	0	0	500	1,000	908	908	908
FLOW (GPM)							
RADON (PICOCURIES/L)	0	0	710,019	565,009	622,078	6,140	6,140
RADON (CURIES/HR)	0	0	0.603	0.960	0.960	0.00947	0.00947
TEMPERATURE (DEG F)	75	75	75	75	40	40	62.3
PRESSURE (INCHES WC)	-0.1	-0.1	-0.1	-0.1			
NOTES	NO FLOW FROM SILO IN PHASE 3	NO FLOW FROM SILO IN PHASE 3		FLOW REPRESENTS WTA PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR INCL. FAN HEAT

PHASE 3

Table 31b: Phase 3 RCS Material Balance

STREAM NUMBER	7	8	9	9A	10	11	12
COMPONENT	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK
AIR (LBS/HR)	0	0	2,161	0		2,161	4,140
WATER (LBS/HR)	0	0	40.7	0	78.0	40.7	2.9
TOTAL (LBS/HR)	0	0	2,201.4	0	78.0	2,201	4,143
FLOW (CFM)	0	0	500	0		500	908
FLOW (GPM)					0.16		
RADON (PICOCURIES/L)	0	0	0	0	310,854	420,000	6,140
RADON (CURIES/HR)	0	0	0	0	0.000011	0.357	0.00947
TEMPERATURE (DEG F)	62.3	62.3	75	62.3	40	75	62.3
PRESSURE (INCHES WC)							
NOTES	NO FLOW TO OR FROM SILOS IN PHASE 3	NO FLOW TO OR FROM SILOS IN PHASE 3	NO FLOW IN STREAM 9 DURING RECIRUCLATION OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA			RELATIVE HUMIDITY=6.4 %

PHASE 3

Table 32c: Phase 3 RCS Material Balance

STREAM NUMBER	13	14	15	16	17	18	19	20
COMPONENT	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	35,004	39,143	0	0		0	0	0
WATER (LBS/HR)	659.1	662	0	0	25,037	0	0	0
TOTAL, (LBS/HR)	35,663	39,805	0	0	25,037	0	0	0
FLOW (CFM)	8,100	9,009	0	0		0	0	0
FLOW (GPM)					50			
RADON (PICOCURIES/L)	0	619.0	0	0	5,501	0	0	0
RADON (CURIES/HR)	0	0.00947	0	0	0.0000625	0	0	0
TEMPERATURE (DEG F)	75	73.7	62.3	75		75	75	75
PRESSURE (INCHES WC)								
NOTES		RELATIVE HUMIDITY=93 .9%	NO FAN RECYCLE IN PHASE 3	TTA INFLOW		EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3

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L- 3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

WASTE HANDLING WORK PLAN

DOCUMENT NO.
624-ACR007-01, Rev. B

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

SUBMITTED TO:

FLUOR FERNALD, INC.

CONTRACT NO. FSC 624

June 20, 2000

CONTENTS

1.0 INTRODUCTION 1
1.1 Organization of Plan 1
1.2 Background 1
1.3 Key Assumptions 1
2.0 SCOPE OF WORK 3
2.1 General 3
2.2 Summary of Approach 3
3.0 WASTE STREAMS 5
3.1 Primary Waste 5
3.1.1 K-65 material 5
3.1.2 K-65 Debris 5
3.1.3 Excavated Soils 5
3.1.4 Buried Drums 6
3.2 Secondary Waste 6
3.2.1 Wastewater 6
3.2.2 Personal Protective Equipment 6
3.2.3 Surrogate Waste 6
3.2.4 Surrogate Solids 7
3.2.5 HEPA Filters 7
3.2.6 Petroleum, Oils and Lubricants 7
3.2.7 Vehicle and Equipment Air, Fuel and Oil Filters 7
3.2.8 Anti-Freeze and Engine Coolant 7
3.2.9 Fixative Spray Paint 7
3.2.10 Sampling Equipment 7
3.2.11 Decontamination Fluids/Materials 7
3.2.12 Miscellaneous Waste 7
3.3 Clean Construction Waste 8
3.3.1 Scrap Metal 8
3.3.2 Wood/Paper Product 8
3.3.3 Clean Debris 8
3.3.4 Sanitary Wastewater and Gray Water: 8
4.0 WASTE HANDLING AND DISPOSITION 9
4.1 Waste Segregation Containerization/Accumulation 9
4.2 Temporary Waste Staging Areas 11
4.3 Spill/Discovery Notification 11
5.0 EQUIPMENT TRANSPORTATION IN THE CONSTRUCTION ZONE 12

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ACRONYMS

AEA	Atomic Energy Act
AWR	Accelerated Waste Retrieval
AWWT	Advanced Waste Water Treatment System
BMP	Best Management Practice
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWRS	Decant Sump Waste Retrieval System
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
Fluor Fernald	Fluor Fernald, Inc.
Foster Wheeler	Foster Wheeler Environmental Corporation
FSMS	Full-Scale Mock-Up System
HP	Health Physics
MSCC	Material Segregation and Containerization Criteria
O&M	operation and maintenance
OSDF	Onsite Disposal Facility
PPE	personal protective equipment
PWID	Project Waste Identification and Disposition Report
RCRA	Resource Conservation and Recovery Act
RCS	Radon Control System
SP	Stockpile
SWRS	Silos Waste Retrieval System
TLCP	Toxicity Character Leaching Procedure
TTA	Transfer Tank Area
TWRS	Transfer Tank Waste Retrieval System
UN	United Nations
WAC	waste acceptance criteria
WHWP	Waste Handling Work Plan

1.0 INTRODUCTION

This Waste Handling Work Plan (WHWP) summarizes activities and compliance requirements associated with the management of wastes generated during construction, testing, and operation and maintenance (O&M) of the Accelerated Waste Retrieval (AWR) Project activities at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. Foster Wheeler Environmental Corporation (Foster Wheeler) is performing the work under Fluor Fernald, Inc. (Fluor Fernald) Contract No. FSC 624.

1.1 Organization of Plan

Section 1 provides and overview of the WHWP, including background and key assumptions supporting the development of this WHWP. Section 2 summarizes the AWR Project scope of work covered by this WHWP. Section 3 identifies applicable waste streams that will be generated and the anticipated waste characterization. Section 4 addresses the handling, segregation, containerization, and movement of waste containers within the AWR Project construction zone and disposition of the waste streams, both onsite and offsite. Section 5 covers documentation, weighing and labeling of waste containers, and transportation issues associated with waste management.

1.2 Background

The FEMP site, owned by the DOE and managed by Fluor Fernald, is located approximately 30 miles northwest of Cincinnati, Ohio. During 1951 to 1960, DOE produced approximately 6,800 cubic meters of material known as K-65 material from processing high-grade uranium ores. Silos 1 and 2 were erected to provide the storage of the material. The silos material contains radionuclides including radium (the contaminant of concern) and thorium. The silos material is classified as 11(e)(2) by-product material in accordance with the Atomic Energy Act (AEA). Therefore, it is excluded from regulation as a solid or hazardous waste under the Resource Conservation and Recovery Act (RCRA) and Title 40 of the *Code of Federal Regulations* (*CFR*) Part 261.4(a)(4).

1.3 Key Assumptions

Waste management activities and compliance practices summarized in the WHWP are based on the following key assumptions:

- **Definition of AWR Project Construction Zone** – The terms "construction zone" for the AWR Project applies to the following areas: (1) the existing Silos 1 and 2 Area; (2) the existing Silo 4; and (3) areas in close proximity to the Silos 1 and 2 where support facility trailers for construction and O&M activities will be located.

- **Transportation in the AWR Project Construction Zone** – Foster Wheeler will containerize as directed and move the waste to a Fluor Fernald-specified location within the construction zone for pickup and transportation by Fluor Fernald to the designated disposal location. Most waste identified for the OSDF or SP-7 will be managed in bulk rather than being containerized.

- **Transportation "Onsite"** – Transportation of waste from the AWR Project construction zone to other facilities is considered an "onsite" activity. Fluor Fernald will be responsible for this onsite transportation.

- **Fluor Fernald Hazardous Waste Determination** – Fluor Fernald will be responsible for determining whether or not the waste is regulated as hazardous waste under RCRA in accordance with 40 CFR 261.3 or Ohio Administrative Code (OAC) 3745-51-03.

- **Waste Sampling** – To sample the silo residues stored in the Transfer Tank Area (TTA) Transfer Storage Tanks, a mobile percussion hammer-coring machine will be operated from a portable enclosure located on the TTA Equipment Deck. Technical requirements TTA-021 through TTA-026 of the AWR Project *Technical Requirements Document* (Document No. 40710-RP-0001) provide requirements for extracting samples of K-65 material and BentoGrout™ (i.e., silo residues) that have been removed from Silos 1 and 2 and stored in the TTA Transfer Storage Tanks. Samples will be taken at a quantity of 15 gallons per 10% of silo residues transferred, or 150 gallons total. After the samples have been withdrawn from the storage tanks, the samples are to be free of liquids, packaged in 55-gallon drums, stored in a shielded, accessible area, and labeled in accordance with applicable AWR Contract requirements.

  Any additional sampling and radiological surveys required for berm soils and buried debris (if found) will be performed by Fluor Fernald and disposed of as determined by Fluor Fernald on the basis of the results of the sample analysis and survey.

- **Equipment Decontamination** – Decontamination of equipment, tools and facility components smaller than 18 feet by 30 feet will be performed in a portable, truck-mounted decontamination facility. In addition, a decontamination pad will be constructed within the construction zone to decontaminate larger equipment. Foster Wheeler personnel will provide initial surveys and will present equipment and survey results to Fluor Fernald for a verification survey.

2.0 SCOPE OF WORK

This section provides a general overview and summary of approach to waste handling activities associated with the AWR Project.

2.1 General

Foster Wheeler will design, construct, operate, and maintain the Radon Control System (RCS), the Pivoting Bridge Support System, the glide track portions of the Silos Waste Retrieval System (SWRS), Decant Sump Waste Retrieval System (DWRS), Full-Scale Mock-Up System (FSMS), the TTA, and the TTA Waste Retrieval System (TWRS). Foster Wheeler will also perform the silo berm removal and spray a fixation agent inside the silos upon completion of waste retrieval.

2.2 Summary of Approach

The Foster Wheeler approach to the AWR Project employs demonstrated technology to safely and effectively remove radioactive decay gases, K-65 waste residues and bentonite, and debris from Silos 1 and 2. The major elements planned for the execution of the AWR Project are:

1. Mobilization and construction of RCS, FSMS, and TTA,
2. Training for and operation of FSMS and RCS,
3. Construction of SWRS,
4. Waste Retrieval Operation at Silo 1,
5. Waste Retrieval Operation at Silo 2,
6. DWRS Operation, and
7. Decontamination and Decommissioning (D&D) and Demobilization.

During the first phase of operations, the accumulated concentration of radon gas in the silo headspaces will be reduced by approximately 75% during the operation of the RCS. Parallel to the operation of FSMS, construction of a pivoting bridge structure will be performed. This bridge structure, which will straddle the existing silos, is to provide a work platform that precludes the placement of unnecessary loads on the silo domes or walls during the operations phase. Only upon successful operation of FSMS and personnel training, Foster Wheeler will start retrieval of waste from the silos.

Retrieval of the waste solids is accomplished remotely with a small number of versatile tools supported from a work platform on the pivoting bridge structure. Four new tanks in a shielded structure (i.e., TTA) erected to the east of the silos will receive and store the solids for future disposition. The debris from the bottom of the silos will be removed remotely using a basket attached to a cable. The basket will be pulled into the air-controlled containment box on the bridge work platform and remotely placed in a 30-gallon drum. Accumulated radon from these tanks will also be constantly exhausted to the on-line RCS. Initially, Silo 1 will be emptied. At the completion of the retrieval operations in Silo 1, the work platform will be pivoted into position over the Silo 2, thereby eliminating the need for a second bridge structure. The berm soil

around the silos will be removed concurrently with the waste removal, such that a berm soil height at least 5 feet higher than the waste level in silos is maintained continuously. The final step for each silo is to spray a fixative on the interior walls, ceiling, and floor to prevent any residual contamination from becoming airborne. After both silos are emptied, the Decant Sump—located west of and between the silos—will be emptied using a similar technique. The berm soil above the sump will be excavated to the extent necessary to allow access into the tank and will be managed in the same manner as berm soil.

Upon completion of waste removal activities, D&D of facilities and equipment installed for the AWR Project and demobilization activities will be initiated by FWENC. The permanent facilities erected during the AWR Project will be decontaminated before beginning demolition of the facilities. Equipment, tools, and temporary facilities will be decontaminated and surveyed before removal from the FEMP site.

3.0 WASTE STREAMS

The waste streams for the AWR Project are divided into three categories: (1) existing primary waste (i.e., the main scope of work for which Foster Wheeler is responsible to retrieve and store in aboveground storage tanks); (2) secondary waste generated by Foster Wheeler during retrieval and storage of the primary waste; and (3) clean construction waste generated during construction and O&M of the facilities required to retrieve the primary waste. All secondary waste will be segregated, characterized, packaged, and dispositioned in accordance with site procedures. Based upon the Final Design, a Project Waste Identification and Disposition (PWID) Report will be prepared in accordance with procedure EW-1021, *Preparation of the Project Waste Identification and Disposition (PWID) Report.* The PWID will document the anticipated waste streams, generation rates, and Fluor Fernald-approved disposition for secondary waste resulting from AWR operations. FWENC will provide data on tracking of secondary waste generated to Fluor Fernald for updating of the appropriate inventory database. As waste is generated, the volumes of each waste stream will be tracked against the PWID, and the PWID will be updated as necessary due to any changes from the initial estimates.

Anticipated generation volumes, potential container requirements and proposed disposition methods for each waste stream are summarized in Table 4-1. The final disposition determination (e.g. offsite, OSDF, SP-7) and resulting container requirements will be determined during development and review of the PWID. The containers and disposition methods identified in Table 4-1 will be updated as required based on the approved PWID.

3.1 Primary Waste

This section provides an overview of the various primary waste streams associated with the AWR Project.

3.1.1 K-65 Material

As discussed earlier, this solid waste material contain radionuclides, including radium-226 (the contaminant of concern) thorium-230, lead-210, bismuth-210, and polonium-210.

3.1.2 K-65 Debris

The debris found in the silos and the Decant Sump will be removed using baskets and a remote arm equipped with a grapple and remotely placed into 30-gallon drums and overpacks and disposed offsite.

3.1.3 Excavated Soils

The AWR Project requires excavation of berm soils around the silos and excavation required to construct the foundations for the bridge structure. These soils may contain radiological contamination. During excavation, a working soil pile will be configured by Foster Wheeler within the AWR Project construction zone to support hauling and placement of soil by Fluor Fernald. The soil pile will be large enough to support two days of hauling. Fluor Fernald will take any necessary samples and radiological surveys of the soil and will direct the disposition of the soil. Excavation and management of the berm soil is discussed in detail in the Berm Excavation Plan, Document 624-P621-11.

3.1.4 Buried Debris

The possibility exists that buried debris (drums, piping, conduit, etc.) could be encountered during excavation of the bridge structure foundations or berm material excavations at the AWR Project site. If buried debris is located, then Foster Wheeler will notify Fluor Fernald. On approval, Foster Wheeler would excavate in accordance with Fluor Fernald direction and uncover the debris. Fluor Fernald will perform any required sampling and analysis and direct disposition of the debris.

3.2 Secondary Waste

During the execution of the AWR Project, additional secondary waste streams will be generated. Also, wastes may be encountered that are not related to site contamination (e.g., heating or fuel oils, lubrication oils, etc.). The following paragraphs give summary data for each of the waste streams anticipated. The container and disposal methods identified in this section are preliminary, and will be finalized during development and review of the PWID. The approved PWID will document the Fluor Fernald-approved container requirements and disposal method for each secondary waste stream.

3.2.1 Wastewater

Water must be added to the silo waste to mobilize and transfer the waste to the TTA. The waste slurry will pass through a settle and decant chamber to minimize water used to transfer waste. The RCS will be equipped with chillers that will produce condensate that has a capacity to absorb radon. The design will minimize the volume of waste water by recycling to TTA. It is estimated that, upon completion of AWR operations, approximately 150,000 gallons of excess wastewater will be discharged to the Advanced Wastewater Treatment System (AWWT) facility after demonstrating compliance with the applicable waste acceptance criteria (WAC). Management of this excess wastewater, including the criteria for discharge to AWWT, is discussed in detail in the Environmental Control Plan, Document No. 624-P621-10.

3.2.2 Personal Protective Equipment

Personal protective equipment (PPE) associated with the AWR Project includes gloves, tyvek suits, coveralls, respirators, and boot covers. The recyclable PPE will be placed in plastic bags and stored in an assigned area in the Health Physics (HP) trailer. The disposable PPE will be placed in plastic bags and stored in a roll-off box (until it is full) located near HP trailer and within a posted radiological area. It is anticipated that the majority of the disposal PPE will be disposed as Category 4 material in the OSDF.

3.2.3 Surrogate Waste

During operation of the FSMS, nonradioactive surrogate wastes will be used at the Silo 4. Using the TWRS slurry pump, the settled surrogate in the TTA tank is sluiced from the tank through the existing TTA pipeline and diverted to Surrogate Settling Tank for slurry dewatering. After the surrogate material dewatering requirements have been satisfied, the material is radiologically surveyed to determine disposition. If the material meets free release criteria, then the material can be disposed of in an approved sanitary landfill. If the surrogate material is cannot be free-released, it will be staged for OSDF or offsite disposal at the direction of Fluor Fernald.

3.2.4 Surrogate Solids

As discussed in Section 3.2.3, nonradioactive surrogate wastes, including solids, will be used for the operation of FSMS at Silo 4. It is anticipated that this clean waste will be certified for free-release by Fluor Fernald and removed from the site by Foster Wheeler.

3.2.5 HEPA Filters

The RCS will be equipped with two parallel banks of high-efficiency particulate air (HEPA) filters. The life of the filters is extended by adding a prefilter in front to remove coarse solids. The used filters and elements will be placed in plastic bags and will be stored in an the appropriate container for disposal.

3.2.6 Petroleum, Oils and Lubricants

This waste stream would be generated as a result of vehicle and equipment maintenance, accidental discharge, or failure of equipment. Liquid residue from this waste will be collected and drummed for disposal or recycling.

3.2.7 Vehicle and Equipment Air, Fuel and Oil Filters

Filters being discarded during routine maintenance of vehicles and equipment will be drained, crushed, and bagged as Category 4 material for disposal at the FEMP Onsite Disposal Facility (OSDF).

3.2.8 Anti-Freeze and Engine Coolant

If generated as a result of spill, accident, or equipment malfunction located on soil or gravel, then the area of the spill is to be over-excavated and stockpiled or hauled to the FEMP OSDF or staged at Stockpile SP–7 for offsite disposal.

3.2.9 Fixative Spray Paint

An accidental spill on soil or gravel is to be over-excavated and stockpiled or hauled to the OSDF or staged at Stockpile SP–7 for offsite disposal.

3.2.10 Sampling Equipment

Equipment used during sampling of K-65 material, soils, and drum contents will be decontaminated and surveyed for free release. If not releasable, the equipment will be inventoried and staged for disposal as Category 2 or 3 material in the OSDF.

3.2.11 Decontamination Fluids/Materials

Rinse water from vehicles and equipment decontamination activities and gray water from shower facility will be collected, sampled, and disposed as wastewater as described in Section 3.2.1.

3.2.12 Miscellaneous Waste

Miscellaneous waste includes plastic materials and paper wipes from decontamination trailers. If this waste is contaminated, then it will be stored in an appropriate container for disposal as Category 4 material in the OSDF.

3.3 Construction Waste

During construction activities, construction waste will be generated as described below. Each category of the construction waste (except gray water) will be segregated by placing in separate containers or stockpiles. The containers will be locked except when waste is being placed in them. The AWR Project Construction Manager or designee will be responsible for maintaining these containers.

3.3.1 Clean Debris

Clean debris such as concrete waste, and unused aggregate will be stockpiled within the AWR Project construction zone but outside the contaminated area. After confirmation that it meets free release requirements, clean debris will loaded into roll-off boxes for free release and transport to an approved sanitary landfill.

3.3.2 Scrap Metal

Scrap metal generated during fabrication and erection of the steel structures will be collected and placed in a separate container for a free-release survey. If decontamination is required, then the metal will be undergo a second free-release survey. Once material has successfully passed this survey, it will be turned over to Fluor Fernald for a verification survey. Scrap metal not able to be free released will be size reduced as necessary and staged for disposal as Category 2 material in the OSDF.

3.3.3 Wood/Paper Product

Wood pallets, cardboard boxes, or similar material will be collected and placed in separate containers for a free-release survey. Material not able to be free released will be staged for disposal as Category 4 material in the OSDF.

3.3.4 Sanitary Wastewater and Gray Water

Sanitary wastewater from toilet facilities and gray water from shower facilities at the AWR Project site will be pumped or otherwise conveyed to the FEMP wastewater collection and treatment system for treatment prior to final discharge from the FEMP site via a permitted outfall.

4.0 WASTE HANDLING AND DISPOSITION

This section of the WHWP summarizes how each of the waste streams described in Section 3 must be segregated, containerized, labeled, accumulated, stored, and disposed.

4.1 Waste Segregation Containerization/Accumulation

Table 4-1 summarizes the waste streams, generation volumes, and proposed container and disposition methods established for the AWR Project. Fluor Fernald will provide appropriate containers for each waste category as identified in Table 4-1. The container and disposal methods identified in Table 4-1 are preliminary, and will be finalized during development and review of the PWID. The points of generation for K-65 material and debris are Silos 1 and 2. The point of generation for the surrogate waste and debris is Silo 4. The point of generation for the wastewater will be the RCS Building and change trailers. The point of generation for the decontamination wastes is the location where the decontamination operations (near the TTA) will be performed. The point of generation for the remaining primary and secondary waste streams will vary across the AWR Project site. The clean construction waste will be maintained outside the contaminated area but within the AWR Project construction zone. The point of generation for sanitary water and gray water will be near the AWR Project support trailers.

Containers or drums used for the primary and secondary waste and the storage area will meet the following criteria:

- Containers will be U.S. Department of Transportation (DOT) United Nations (UN) specification drums (e.g., 1A2 for open-top steel drums).
- Containers will be inspected for leaks at least once each week during the storage period.
- Containers will be "marked" with removable markings that include the contents and date the first amount of material was put into the container.
- Containers will be "marked" with removable markings that include the label: "Caution, contains K-65 debris..."
- Storage area will be delineated and "marked" with a sign indicating the Fluor Fernald-required wording: "Caution, contains K-65 debris...."

Additional Best Management Practices (BMPs) for the drum storage areas containing primary and secondary waste will be employed as follows:

- For drum storage area, the containers will be covered with an anchored poly tarp.
- The drum storage area will have a minimum 6-inch curb to minimize spread of contamination.
- The drums will be on wooden pallets, within a locked, fenced-in area for overnight storage (to prevent unauthorized access).
- A written record will be kept which includes (at a minimum: the number of drums, contents of each drum, and dates placed/removed from the storage area).

TABLE 4-1. AWR PROJECT WASTE HANDLING SUMMARY

TASK NUMBER (SEE DESCRIPTIONS BELOW)	WASTE STREAM / ESTIMATED QUANTITIES	Potential Containers[2]							
		LARGE METAL BOX (TOP LOADER)	SMALL METAL BOX		ISO	DRUM	ROLL-OFF BOX	NO CONTAINERS (BULK)	ANTICIPATED DISPOSITION
			B-12	B-25					
4, 5, 6	K-65 Material (Category C)							X	TTA Tanks
4, 5, 6	K-65 Debris (Category C)					X			Offsite (NTS, etc.)
1, 3, 4, 5	Excavated Soils (Berm Soil) / 11,000 cubic yards							X	OSDF Cat. 1
1, 3	Buried Debris							X	OSDF Cat. 2
1, 2, 3, 4, 5, 6, 7	Wastewater (Category C) / 150,000 gallons [1]							X	AWWT
1, 2, 3, 4, 5, 6, 7	PPE / 100 cubic yards	X						X	OSDF Cat. 4
2	Surrogate Waste / 200 cubic yards (includes debris *)						X		Free release
2	Surrogate Debris *							X	Free release
1, 2, 3, 4, 5, 6, 7	Petroleum, oils and Lubricants / 200 gallons (includes ** items)					X			Offsite / OSDF
1, 2, 3, 4, 5, 6, 7	Air, Fuel and Oil Filter / **					X			OSDF Cat. 4 or SP-7
1, 2, 3, 4, 5, 6, 7	Anti Freeze /Engine Coolant Spill material **							X	OSDF Cat. 4 or SP-7
4, 5	Fixative Spray Paint Spill material							X	OSDF Cat. 4 or SP-7
1, 2, 3, 4, 5, 6, 7	Sampling Equipment	X						X	Free release or OSDF Cat. 2/3
3, 4, 5, 6, 7	Decontamination Fluids and Material / 15,000 gallons water ,50 cubic yards debris							X	AWWT (fluid) OSDF Cat 4
1, 2, 4, 5, 6, 7	HEPA Filters / 12 cubic yards	X							OSDF / offsite
1, 2, 3, 4, 5, 6, 7	Miscellaneous Waste / 10 cubic yards						X		OSDF Cat. 4
1, 2, 3, 4, 5, 6, 7	Scrap Metal / 300 cubic yards						X		Free release/ OSDF Cat 2
1, 2, 3, 4, 5, 6, 7	Wood Paper Product / 300 cubic yards	X					X		Free release/ OSDF Cat 4
1, 2, 3, 4, 5, 6, 7	Clean Debris / 110 cubic yards						X		Free release
1, 2, 3, 4, 5, 6, 7	Sanitary Wastewater and Gray Water							X	AWWT

Notes: [1] Potable water used for testing of the TTA tanks will be held for use during FSMS testing and subsequent waste retrieval operations. Approximately 150,000 gallons of excess water will be directed to the AWWT facility at the end of AWR Project operations.

[2] Final container requirements and disposal locations will directed by Fluor Fernald, documented in the approved PWID

TASK NUMBERS AND DESCRIPTIONS

NO.	DESCRIPTION	NO.	DESCRIPTION
1	Mobilization and construction of RCS, FSMS, and TTA	5	Waste Retrieval Operation at Silo 1
2	Training for and operation of FSMS and RCS	6	DWRS Operation
3	Construction of SWRS	7	D&D and Demobilization
4	Waste Retrieval Operation at Silo 2		

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- For RCRA-regulated hazardous wastes, a "Hazardous Waste" label will be used. The label must include: The generator's name, accumulation start date, waste code(s), DOT proper shipping name and DOT Identification number.

- For hazardous wastes (e.g., oils, fuels), all applicable labeling requirements will be satisfied, including assignment of specific waste codes if applicable.

PPE associated with the AWR Project will be accumulated in plastic bags for pickup by Fluor Fernald personnel. Separate bags will be used for cloths, gloves, and booties. Disposable PPE will be placed in roll-off boxes until full.

4.2 Temporary Waste Staging Areas

The temporary waste staging areas are shown on Drawing Number 05FCD014, Miscellaneous Facilities Site Space Allocation. As discussed previously, dumpsters and roll-off boxes containing clean debris will be locked, and loading/unloading will be supervised to prevent accidental disposal of the contaminated waste.

4.3 Spill/Discovery Notification

A release/spill of waste will be properly contained as soon as practical after the release occurs. As a proactive measure, spill response kits and equipment will be available at temporary staging locations, including near the Silos 1 and 2 in the contaminated area, Silo 4 area, and the construction staging area (clean area). (See the *Contingency Plan and Emergency Response*, AWR Project Document No. 624-P621-09, regarding the contents of the spill response kits and type of equipment required).

As a preventive measure, drip pans and other precautionary measures will be employed during routine maintenance of vehicle and equipment. These measures serve to minimize the impact of an oil or lubricant released from vehicles or equipment. If oil or hazardous materials not related to site contamination are discovered (e.g., soils, solvents, etc.), then the Fluor Fernald Project Manager will be notified.

5.0 EQUIPMENT TRANSPORTATION IN THE CONSTRUCTION ZONE

The major pieces of equipment that will be used to move drums and dumpsters and to load or unload stockpiles in the AWR Project construction zone are as follows:

- **Drums** – The drums containing K-65 debris and surrogate debris from silos will be loaded in a trolley on the bridge, lowered down to the ground using a hoist and then moved to the drum storage area by a forklift.

- **Dumpsters** – Clean dumpsters and roll-off boxes will be placed at designated locations only. Fluor Fernald will use special equipment to load and unload waste from these containers.

- **Stockpile** – A backhoe, loader, and dump truck will be used to load and unload excavated material and debris from the stockpile area.

3.0 ARAR COMPLIANCE SUMMARY

The following exhibits provide compliance matrices for the ARARs or To Be Considered (TBC) requirements associated with the AWR Project. These matrices provide an assessment and general description of the compliance strategy for each ARAR or TBC requirement, along with references to specific AWR Project documents that more fully describe the related compliance strategy and methods.

Exhibit 3-1 contains ARARs and TBC requirements that are defined as being chemical-specific to the AWR Project. Exhibit 3-2 contains ARARs and TBC requirements that are defined as being location-specific to the AWR Project. And finally, Exhibit 3-3 contains ARARs and TBC requirements that are defined as being action-specific to the AWR Project.

Exhibit 3-1: Chemical-Specific Applicable or Relevant And Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Radionuclide Emissions (Except Airborne Radon-222)	Title 40 of the Code of Federal Regulations (CFR) Part 61, Subpart H. Emissions of radionuclides to ambient air from a US Department of Energy (DOE) facility shall not exceed an amount that might cause a member of the public to receive an effective dose equivalent (EDE) of 10 mrem/yr. Monitoring is required at release points having potential to discharge radionuclides that could cause an EDE in excess of 1% of standard (0.1 mrem/ year) 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.	Emissions of all materials in the silos will be minimized by using sealed hatches and piping. The RCS is designed to operate at a negative pressure. The RCS stack will have an isokinetic sampling system and all discharges will be continuously monitored for radioactivity. Stack alarms and backup power are also provided.	See sections on the Radon Control System (RCS) and the Heating, Ventilating, and Air Conditioning (HVAC) Systems of the Functional Requirements Document (FRD), Document No. 40710-624-P622-02. Also, see the AWR Project Environmental ALARA Report, Document No. 40710-624-P622-10B, and Section 2.1, Air Emissions Control, of this ECP for additional information.
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 the silo residues. Interim storage of silo residues, including the TTA, qualify as sources.	Source storage units (i.e., TTA tanks) are sealed and headspace radon gas is treated by the RCS. Monitoring of the treatment discharge will demonstrate compliance with 40 CFR 61, Subpart Q, and DOE Order 5400.5. A radon monitor is installed in the horizontal run of duct between the HEPA filters and the stack, and will draw air samples from the stack, with results fed back to the AWR Control Room for readout and recording. Continuous radon monitoring is provided. Emissions are to be controlled to result in a maximum annual average fence line impact of 0.5 pCi/L.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.

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Exhibit 3-1: Chemical-Specific Applicable or Relevant And Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Protection of Air from Residual Radioactive Material	DOE Order 5400.5, Chapter 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.	Emissions of all materials in the silos will be minimized by using sealed hatches and piping. The RCS is designed to operate at a negative pressure except for a portion of the recycle line between the carbon beds and the return damper. Continuous radon monitoring is to be conducted on the RCS stack discharge to determine compliance with DOE Order 5400.5. The RCS stack has an isokinetic sampling system and all discharges are to be continuously monitored for radon and particulate radionuclides. Stack alarms and backup power are also provided.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.
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 National Pollutant Discharge Elimination System (NPDES) permit.	The process minimizes the water used to transfer the silo waste material, thereby minimizing the wastewater discharge to the AWWT. Water sent to the AWWT is first sampled, analyzed, and radiologically surveyed to meet the AWWT WAC, and therefore, meets the requirements of the site NPDES permit limits. The existing concrete storm water trench drain around the perimeter of the silos will be maintained. The trench drain leads to a rectangular concrete sump located to the northwest of the silos. No other contaminated storm water is expected to be discharged during any phase of the AWR Project.	See sections on the Storm Water System and the Wastewater System of the FRD, as well as Sections 2.3 and 2.4 of this ECP for additional information.

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Exhibit 3-1: Chemical-Specific Applicable or Relevant And Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
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; and • Nutrients that create nuisance growth.	Requires compliance with the FEMP NPDES permit.	See above discussion relating to control of wastewater and storm water discharges associated with the AWR Project.	See sections on the Storm Water System and the Wastewater System of the FRD, as well as Sections 2.3 and 2.4 of this ECP for additional information.
*OEPA NPDES Permit No. 1I000004*FD*	Wastewater 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 the Ohio Environmental Protection Agency (OEPA) of any activities or changes at the site which have the potential to significantly alter the character of the wastewater 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 wastewater stream. The existing NPDES permit must also be modified to reflect the addition of any new point source discharges of process wastewaters and storm waters.	Wastewater must be eliminated, recycled, or minimized during the AWR Project to the extent practicable. Wastewater discharges associated with the AWR Project wastes must be pretreated, if required, to ensure compliance with NPDES permit requirements.	FDF, in consultation with Foster Wheeler, determines the necessity for modifying the FEMP NPDES, and if required, submits a modification request to OEPA a minimum of 180 days prior to initiation of operation.	See sections on the Storm Water System and the Wastewater System of the FRD, as well as Sections 2.3 and 2.4 of this ECP for additional information.

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Exhibit 3-2: Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Endangered Species Protection	50 CFR Part 402; Ohio Revised Code (ORC) 1518, 1513.25; and OAC 1501-18-1-01. Federal agencies must not jeopardize the continued existence of any endangered or threatened species, or destroy and adversely modify critical habitat of such species.	The FEMP is located within the range of the Indiana bat, a federally listed endangered species. In addition, the Sloan's Crayfish has been located in the Paddy's Run corridor. Therefore, this requirement is relevant and appropriate. Any potential impacts of the remedial actions on this species must be evaluated and appropriate actions taken.	Pictures and descriptions of endangered species are to be posted in the change trailer and in the break room trailer. All construction and operating personnel are to be instructed to notify managers whenever animals are encountered on the AWR Project site. No disturbance (e.g., excavation, removal of trees, etc.) is planned near the Paddy's Run corridor. Drainage patterns will be maintained to prevent impacts to Paddy's Run due to runoff, spills, or releases.	Methods of accomplishment to satisfy this ARAR are to be documented in the Project Specific Health and Safety Plan, Document No. 624-P8B21-01. See also Section 2.4 of the Environmental Control Plan.
Compliance with Floodplains/ Wetlands Environmental Review Requirements	10 CFR Part 1022; and 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.	Wetlands are not being impacted by the project. All work occurs in areas that have been historically used for OU 4 construction and operations.	The CFC drawings and construction specifications address requirements of wetland mitigation in the unlikely event that they are encountered.

Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
National Environmental Policy Act (NEPA) Evaluations	10 CFR 1021.2. DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality regulations in 40 CFR 1500-1508.	A NEPA Supplemental Analysis has been prepared and approved addressing NEPA requirements for the AWR Project.	A NEPA analysis has been completed. This analysis is reviewed to ensure that AWR Project activities are being performed within its framework.	The CFC drawings and specifications reflect mitigation of NEPA concerns if identified.
Nationwide Permit Program	33 CFR 330. The US Army Corps of Engineers (USACE) 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 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 NWP 12 and NWP14.	Roads and utilities to support this project are currently being constructed (by others). The plans were prepared by Fluor Daniel Northwest, Project 40315, June 1998. All of the intrusive work for the AWR Project takes place within the perimeter road currently being constructed. No wetlands are to be disturbed. No trees are to be removed. All work occurs in areas that have historically been used for OU 4 construction and operations, and therefore, permitting is not anticipated to be required.	See the CFC drawings and construction specifications regarding delineation of work areas and related mitigation measures to implement during construction.
Discharge of Storm Water Runoff	40 CFR 122.26; and OAC 3745-38. Storm water runoff from landfills, construction sites, and industrial activities must be monitored and controlled. A Storm Water 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 sites and construction site of greater than 5 acres that discharge storm water runoff to the waters of the US. This requirement is applied through the FEMP NPDES Permit.	The existing concrete storm water trench drain around the perimeter of the silos will be maintained. The trench drain leads to a rectangular concrete sump located to the northwest of the silos.	See section on the Storm Water System of the FRD, as well as Section 2.4 of this ECP for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Discharge of Treatment System Effluent	40 CFR 125.100; and 40 CFR 125.104. Best Management Practices: Develop and implement a BMP program to prevent the releases of toxic or hazardous pollutants to waters of the US. Development and implementation of a site-wide 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; and • 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 release 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.	BMP requirements for management of hazardous materials stored or used in the AWR Project (e.g., storage of fuel for an emergency generator) are implemented through the FEMP site SWPPP.	Not applicable.
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 materials 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.	Test holes and monitoring wells are to be filled with grout and also contain a layer of bentonite. Requirements are shown by means of a CFC drawing detail and construction specification.	See the CFC drawings and construction specifications for methods of abandonment.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
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 Silos 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.	Appropriate design controls, as discussed in Exhibit 3-1 for compliance with other ARARs related to controlling and monitoring radon air emissions, are being provided for the RCS. These controls also meet the requirements of this ARAR. Groundwater monitoring is not within the scope of the AWR Project.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.
Hazardous Waste Determinations	40 CFR 262.11; and 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 if from definition as a "solid waste"; • To identify whether a particular solid waste might be classified as a hazardous waste; and • To determine if a material otherwise classified as a "hazardous waste" might be excluded from Resource and Conservation Recovery Act (RCRA) regulation.	Procedures are established to determine whether wastes are subject to the requirements of RCRA. The materials in Silos 1 and 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate to determine whether OU 4 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 Toxicity Characteristic Leaching Procedure (TCLP) results. Silos 1 and 2 contain material that must be treated, stored, and disposed in accordance with RCRA.	The generation of secondary waste for the AWR Project is to be minimized as much as possible. Wastes are characterized and identified, as necessary, according to the requirements of 40 CFR 261. A satellite accumulation area is to be provided for these wastes at the AWR Project site, as appropriate. Newly generated hazardous waste is not expected from the AWR Project.	See the Waste Handling Work Plan for the AWR Project, Document No. 40710-624-ACR007-01, for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Empty Containers	40 CFR 261.7; and OAC 3745-51-7. Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if one or more of the following are met: No more than 2.5 cm (1 in) of residue remains on bottom of inner liner; Less than 3% by weight of total capacity remains (≤ 110-gal container); and Less than 0.3% by weight of total capacity remains (> 110-gal container). Exemption requirements for containers that have held acutely hazardous ("P" listed) wastes are somewhat more restrictive.	The materials in Silos 1 and 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the materials stored in Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) Containers used to treat or store the contents of Silos 1 and 2 might contain residues that exhibit hazardous waste characteristics that may be removed before the containers might be reused or disposed.	Hazardous waste containers are not emptied and reused as part of the work scope under the AWR Project.	See the Waste Handling Work Plan for the AWR Project for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	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; 40 CFR 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 materials 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 Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits 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.	The generation of secondary waste for the AWR Project is to be minimized as much as possible. Newly generated hazardous or mixed waste is not expected from the AWR Project that would require off-site treatment, storage or disposal.	See the Waste Handling Work Plan for the AWR Project for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Treatment, Storage, or Disposal Facility Standards	40 CFR 264, Subpart B; and OAC 3745-54-13 through 16. ***General Standards:*** These include: ***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-hr 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 for regular inspections.	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 Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) Waste removed from this operable unit which exhibits a hazardous characteristic, similar to RCRA hazardous waste, must be treated, stored, and disposed in accordance with treatment, storage, or disposal (TSD) facility standards.	RCRA TSD facility standards apply to the design and operation of the AWR Project, and as such, has been reflected in appropriate design drawings and specifications, as well as operating and maintenance procedures. Representative samples of waste are to be collected, security provided through 24-hr surveillance system, and inspections performed, as appropriate, of processing systems while attention to ALARA principles is applied to all appropriate AWR Project activities.	See the CFC drawings and specifications, as well as the Contingency Plan and Emergency Response (Document No. 40710-624-P621-09), which is to be submitted 60 days prior to construction, and other various AWR Project operating procedures.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Treatment, Storage or Disposal (TSD) 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 non-sudden 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 2-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.	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 Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) Waste removed from this operable unit which exhibits a hazardous characteristic must be treated, stored, or disposed in accordance with TSD facility standards.	RCRA TSD facility standards apply to the design and operation of the AWR Project, and as such, has been reflected in appropriate design drawings and specifications, as well as operating and maintenance procedures. Representative samples of waste are to be collected, security provided through 24-hr surveillance system, and inspections performed, as appropriate, of processing systems while attention to ALARA principles are applied to all appropriate AWR Project activities. Applicable OAC requirements for emergency preparedness and prevention have also been incorporated into the design of the AWR Project facilities, as well as the operating and maintenance procedures for the AWR Project. These procedures included the testing and maintenance of emergency systems.	See the CFC drawings and specifications, as well as the Contingency Plan and Emergency Response, which is to be submitted 60 days prior to construction, and other various AWR Project operating procedures.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	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 though 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 fire, 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.	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 wastes stored in Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) Wastes removed from this operable unit which exhibits a hazardous characteristic must be treated, stored, or disposed in accordance with TSD facility standards.	RCRA TSD facility standards apply to the design and operation of the AWR Project, and as such, has been reflected in appropriate design drawings and specifications, as well as operating and maintenance procedures. Representative samples of waste are to be collected, security provided through 24-hr surveillance system, and inspections performed, as appropriate, of processing systems while attention to ALARA principles are applied to all appropriate AWR Project activities. Applicable OAC requirements for emergency preparedness and prevention have also been incorporated into the design of the AWR Project facilities, as well as the operating and maintenance procedures for the AWR Project. These procedures included the testing and maintenance of emergency systems.	See the CFC drawings, and specifications, as well as the Contingency Plan and Emergency Response, which is to be submitted 60 days prior to construction, and other various AWR Project operating procedures.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Closure	40 CFR 264, Subpart G; OAC 3745-55-11; OAC 3745-55-14; and OAC 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; and • 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 Silos 1 and 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the wastes stored in Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. Contractor's facility must be clean closed, or else media remediation to meet closure performance standard. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.)	Equipment or items used in performance of work that require decontamination are cleaned per approved plans. TTA is not closed as part of this scope of work.	Decontamination wastes are described in the AWR Project Waste Handling Work Plan.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Container Storage	40 CFR 264, Subpart I; and 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); and 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% of the volume of the largest container of free liquids. Remove spilled or leaked waste in a timely manner.	The materials 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 Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) These requirements are relevant and appropriate for alternatives utilizing containers for temporary storage or storage before disposal.	No hazardous material is expected to be newly generated from the AWR Project. All secondary waste is handled per the approved Waste Handling Work Plan.	See the AWR Project Waste Handling Work Plan for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Tank Systems	40 CFR Part 264, Subpart J; and OAC 3745-55-91 through 96. Design, operating standards, and inspection requirement 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; and • 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 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 Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits 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.	The tanks and equipment used to store silos material in the TTA are designed for material compatibility and strength, and also provide secondary containment capable of detecting and collecting releases. Operating standards are to meet FEMP requirements, including the inspection of tank integrity and leak detection systems that are performed by remote closed circuit television (CCTV) technology.	Design criteria for the TTA system is provided in the Design Criteria Package for the AWR Project, Document No. 40710-624-P622-03. Additional information is also provided in the FRD and the Process Descriptions (Document No. 40710-624-P622-20) for the AWR Project.

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31 57

Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Closure Requirements for Tanks	40 CFR 264.197; and 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; and • 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 appurtenances used to store or treat Silos 1 and 2 material during remediation. These requirements are relevant and appropriate because circumstances and wastes subject to potential release are similar to those RCRA is designed to address.	Tanks that are used to store or treat silo material are not to be closed under the AWR Project scope of work. Equipment or items used in performance of work that require decontamination are to be cleaned per approved plans.	Decontamination wastes are described in the AWR Project Waste Handling Work Plan.
Miscellaneous Units	40 CFR 264, Subpart X; and 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 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 Silos 1 and 2 are sufficiently similar to hazardous waste based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) Miscellaneous units might be utilized under various alternatives to stabilize waste that is sufficiently similar to hazardous waste.	The use of RCRA miscellaneous units is not proposed for the AWR Project, and therefore, this requirement does not apply.	Not applicable.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Corrective Action for Solid Waste Management Units (SWMUs)	40 CFR 264, Subpart S; and 40 CFR 264.552 and 264.553. 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 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 Silos 1 and 2 are sufficiently similar to hazardous waste based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) During the process of remediation, waste materials might require temporary management for the purpose of staging or treating material.	Material is staged and stored in accordance with approved AWR Standard Operating Procedures (SOPs). Waste materials are not being treated under the scope of work for the AWR Project. Temporary management of waste materials is performed per approved Waste Handling Work Plan.	See the AWR Project Waste Handling Work Plan for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Containment Building	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 material 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.	The material in the silos is specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silos 1 and 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibits a hazardous characteristic.) During the process of remediation, waste materials might require temporary management for the purpose of staging or treating the material.	The TTA enclosure meets the requirements for containment buildings by providing a fully enclosed facility that prevents exposure to the elements while ensuring containment of the waste materials. Compatible materials of sufficient strength and secondary containment and leak detection are provided.	See sections on TTA in the Design Criteria Package and the FRD for the AWR Project. Additional information is also provided in the Process Descriptions for the AWR Project.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Radiation Dose Limit (All Pathways)	DOE Order 5400.5, Chap. II, Sec. 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 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.	The wastes to be handled as part of the AWR Project exhibit characteristics that may be radiological in nature; however, appropriate design controls, including shielding and layers of containment of the waste features that isolate workers and the public from these wastes, have been applied to the design of the appropriate systems. The law (10 CFR 835) also requires administrative controls to further reduce radiation exposure levels to as low as reasonably achievable (ALARA). ALARA principles are accomplished by radiological protection practices such as maximizing distance between the workers and the radiation source, shielding the workers from the radiation source, or minimizing the time or duration of the workers' exposure to the radiation source.	See the ALARA Analysis for the AWR Project.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
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.	Potential dust-generating activities that are conducted as part of the AWR Project are to be closely monitored for visible emissions, while being controlled using best management practices (BMPs) as necessary. For example, the use of water or other suitable dust suppression chemicals are to be used for controlling dust from activities associated with demolition, construction operations, grading roads, or clearing land. Open trucks are covered when transporting materials likely to become airborne. Also, soil stockpile areas are covered with canvas, plastic, or other suitable material during stockpiling and staging operations. RM-0047 contains the BAT determination for the FEMP site, including the applicable emission standards.	See Section 2.2, Dust Control, of this ECP and the Fugitive Dust Control Plan for the AWR Project, Document No. 40710-624-P6455-01, for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
Prevention of Air Pollution Nuisance	ORC 3704.01-.05; and 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.	Emissions of all materials in the silos are minimized by using sealed hatches and piping. The RCS is designed to operate at a negative pressure. The RCS stack has an isokinetic sampling system and all discharges are continuously monitored for radioactivity. Stack alarms and backup power are also provided.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.

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Exhibit 3-3: Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR/TBC Requirement	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% opacity is prohibited. Transient exceedence limits are included in this regulation.	This requirement is applicable to AWR Project activities.	Particulate emissions greater than 20% opacity are not anticipated for the AWR Project.	Information related to opacity requirements are discussed in the Fugitive Dust Control Plan and the AWR Operations Training Plan (Document No. 40710-624-P6315-02.
Permit to Install (PTI)	OAC 3745-31-05 (A)(3). The Director of Ohio Environmental Protection Agency (EPA) 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 PTI 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. Ohio EPA may also require stack performance testing to evaluate controls.	Air emissions are controlled via the RCS, which is designed to operate at a negative pressure and includes BAT such as carbon beds and HEPA filtration. Emission monitoring equipment is provided per 40 CFR 61 requirements (see Exhibit 3-1 for ARARs relating to radionuclide emissions). Foster Wheeler is to conduct performance tests of air pollution control systems to demonstrate compliance for Ohio EPA as necessary.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.
Ohio EPA Air Toxics Policy [used in conjunction with OAC 3745-31-05 (A)(3)]	The current PTI regulations provide the Director of Ohio EPA with a mechanism to require the evaluation of toxic air contaminants from new sources. The Ohio EPA 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.	The AWR air pollution control systems are designed and installed per applicable codes, standards, and regulations. Emission monitoring equipment is provided per 40 CFR 61 requirements (see Exhibit 3-1 for ARARs relating to radionuclide emissions). Foster Wheeler is to conduct performance tests of air pollution control systems to demonstrate compliance for Ohio EPA as necessary.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.

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4.0 FUNCTIONAL AREA REQUIREMENTS COMPLIANCE SUMMARY

This section summarizes the design and operational control strategy related to the AWR Project to ensure compliance with the appropriate FEMP functional area requirements. The FEMP functional areas are listed in Section 4.1. Two of the functional areas (EP and EW) are within the primary scope of this ECP, and are addressed in Sections 4.2 and 4.3. Most of the functional area requirements are previously addressed in the ARAR Compliance Summary, Section 3.0.

4.1 Description of Functional Areas

Project work at the FEMP site is organized into 24 functional areas. Each functional area consists of related activities or processes with similar environmental, health, or safety concerns. In addition to the ARARs and TBC requirements listed in Section 3.0, the project design must meet requirements that are defined by a functional area. Exhibit 4-1 contains the complete list of the 24 functional areas, and identifies the 15 functional areas that interface directly with ED (Engineering Design), as specified in the AWR Technical Requirements Document (TRD).

Exhibit 4-1: FEMP Functional Area Descriptions

Number	Interfaces with ED	Functional Area (Acronym and Name)	
1	Yes	CM	Configuration Management
2	Yes	ED	Engineering Design
3	No	EM	Emergency Preparedness and Management
4	No	RD	Research and Development and Experimental Activities
5	Yes	EP	Environmental Protection *
6	Yes	FP	Fire Protection
7	No	MT	Maintenance
8	Yes	MS	Management Systems
9	Yes	NS	Nuclear and System Safety
10	Yes	SH	Occupational Safety and Health
11	Yes	OP	Operations
12	No	PT	Packaging and Transportation
13	Yes	QA	Quality Assurance
14	Yes	RP	Radiological Protection
15	Yes	SE	Security
16	Yes	TR	Training and Qualification
17	Yes	EW	Environmental Restoration and Waste Management **
18	Yes	CT	Construction
19	Yes	AC	Acquisition
20	No	HR	Human Resources and Employee Relations
21	No	PC	Project Control
22	No	PM	Property Management
23	No	PI	Public Involvement
24	No	FM	Financial Management

Notes:
* EP functional area requirements are described in Exhibit 4-2.
** EW functional area requirements are described in Exhibit 4-3.

4.2 Compliance Summary for EP Functional Area

Exhibit 4-2 identifies the AWR Project requirements for the Environmental Protection (EP) functional area and matches the EP requirement to the associated ARAR or TBC requirement. The EP functional area requirements (listed in Appendix B of the TRD) are adequately addressed within the ARAR compliance matrices of Section 3.0, except for four instances, which are addressed in Exhibit 4-4.

The EP functional area is concerned with various environmental laws and regulations that protect the land, water, air, biota, flora, and other components of the natural environment. The EP requirements are not specifically defined in terms of engineering activities, but are focused on allowable human interactions with the natural environment.

Exhibit 4-2: AWR Project Requirements Summary for EP Functional Area

Regulation	EP Functional Area Requirement	Matching ARAR/TBC Requirement
National Environmental Policy Act (NEPA)	10 CFR 1022; Compliance Floodplain/Wetlands Environmental Review	Exhibit 3-2
	10 CFR 1021.2; NEPA Implementation	Exhibit 3-3
Federal Water Pollution Control Act (FWPCA) and Clean Water Act (CWA)	40 CFR 122.26 (OAC 3745-38); Discharge of Storm Water Runoff	Exhibit 3-3
	40 CFR 125.100 and 125.104; Best Management Practices	Exhibit 3-3
	33 CFR 330, Appendix A; USACE Nationwide Permits and Conditions	Exhibit 3-3
	OAC 3745-31; Permits to Install New Sources of Pollution	Exhibit 3-3
	OAC 3745-1-04; Protection of Surface Waters	Exhibit 3-1
Safe Drinking Water Act (SDWA)	OAC 3745-95; Backflow Prevention and Cross-Connection Control	Exhibit 4-4
	OAC 3745-9-10; Ohio Water Well Standards	Exhibit 3-3
Superfund, Emergency Planning, and Community Right-to-Know Programs	40 CFR 302; Designation, Reportable Quantities, and Notification	Exhibit 4-4

Exhibit 4-2: AWR Project Requirements Summary for EP Functional Area

Regulation	EP Functional Area Requirement	Matching ARAR/TBC Requirement
Clean Air Act (CAA)	40 CFR 61, Subpart H; National Emission Standards for Emission of Radionuclides Other Than Radon from Department of Energy Facilities	Exhibit 3-1
	40 CFR 61, Subpart Q; National Emission Standards for Radon Emission from Department of Energy Facilities	Exhibit 3-1
	OAC 3745-15-07 and ORC 3704.01 thru.05; Prohibitions of Violations and Air Pollution Nuisance	Exhibit 3-3
	OAC 3745-17-07; Control of Visible Particulate Emissions from Stationary Sources	Exhibit 3-3
	OAC 3745-17-08; Control of Fugitive Dust	Exhibit 3-3
	OAC 3745-31-05(A); Permits to Install New Sources of Pollution, Criteria for Decision	Exhibit 3-3
	OAC 3745-31-35-02(C); Criteria for Air Permits to Operate	Exhibit 4-4
Radiation Protection of the Public and the Environment	DOE Order 5400.5, Chapter II.1.a; Requirements for Radiation Protection of the Public and the Environment (Radiation Does Limit, All Pathways)	Exhibit 3-3
	DOE Order 5400.5, Chapter III; Derived Concentration Guides for Radionuclides in Air and in Water	Exhibit 4-4

4.3 Compliance Summary for EW Functional Area

Exhibit 4-3 addresses the AWR Project requirements for the Environmental Restoration and Waste Management (EW) functional area. The EW functional area requirements (listed in Appendix B of the TRD) are adequately addressed within the ARAR compliance matrices of Section 3.0, except for one instance, which is addressed in Exhibit 4-4.

The EW functional area is focused on the performance of many different projects at the FEMP project site to safely decontaminate and commission the various DOE facilities. Remediated areas are generally restored to natural conditions whenever feasible. The treatment, storage, disposal, transportation, and management of hazardous wastes will continue for many years.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or Superfund) is the statutory driver for remediation at the FEMP, and requires the establishment of project-specific ARARs for all portions of remediation. Since CERCLA itself offers no specific

ARARs for the AWR Project, it is not included in Exhibit 4-3. In addition, the Amended Consent Agreement, September 20, 1991 (as modified by Dispute Resolution 1997) for the FEMP site establishes milestones and schedules, but does not specify ARARs, and therefore, it is also not included in Exhibit 4-3.

Exhibit 4-3 AWR Project Requirements Summary for EW Functional Area

Regulation	EW Functional Area Requirement	Matching ARAR/TBC Requirement
Resource Conservation and Recovery Act (RCRA)	40 CFR 262 and OAC 3745-52; Standards Applicable to Generators of Hazardous Waste	Exhibit 3-3
	40 CFR 263 and OAC 3745-53; Transportation Requirements	Exhibit 3-3
	40 CFR 264 and OAC 3745-54; Standards for Treatment, Storage, and Disposal Facilities • Subpart B (General Facility Standards); • Subpart C (Preparedness and Prevention); • Subpart D (Contingency Plan); • Subpart I (Container Storage); • Subpart J (Tank Systems); • Subpart S (Corrective Action Management Units); and • Part 264.1101 (Containment Buildings).	Exhibit 3-3
	OAC 3745-400; Ohio Construction Demolition Debris Rule	Exhibit 4-4
DOE Orders	DOE Order 5400.5, Chapter IV.6.b; Control of Residual Radioactive Material (Radon) During Interim Storage	Exhibit 3-1

Exhibit 4-4: EP and EW Functional Requirements Summary (not otherwise referenced to ARARs or TBCs)

Category / Description	Functional Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
EP / Backflow Prevention and Cross-Connection Control	ORC 6109; and OAC 3745-95.	The SDWA establishes national standards for regulation of drinking water. The FEMP now has a public drinking water system due to the connection with City of Cincinnati Water Works (CCWW) in 1996. Therefore, backflow protection is required to protect CCWW from process water entering.	Fresh water is supplied to the process from the Fresh Water Surge Tank, which is designed to prevent backflow into the FEMP site fresh water supply. This design also meets the criteria for air gap separation per OAC 3745-95. Check valves are also designed into the system at the point of connection.	See description in the section on the AWR Utility Systems of the FRD regarding domestic water system for the AWR Project.
EP / Designation, Reportable Quantities, and Notification	40 CFR 302.	This regulation designates under CERCLA those hazardous substances with reportable quantities and their respective notification requirements if released to the environment. This regulation also applies to the hazardous substances designated under the CWA.	Secondary containment is provided for the various systems involved in the processing of the silo wastes. Leak detection and pump shutdown interlocks are provided on secondary containment transfer lines. Process tank fill levels are remotely monitored and alarmed. Redundancies are provided for key pieces of equipment. All unplanned releases are evaluated for notification and reporting in accordance with 40 CFR 302 requirements. Emissions of all materials in the silos are minimized by using sealed hatches and piping. The RCS is designed to operate at a negative pressure. The RCS stack has an isokinetic sampling system and all discharges are continuously monitored for radioactivity. Stack alarms and backup power are also provided.	See sections on the TTA and the AWR Control Systems of the FRD. Also, a Contingency Plan and Emergency Response is to be prepared for the AWR Project and provided to FDF for review 60 days prior to start of construction.

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Exhibit 4-4: EP and EW Functional Requirements Summary (not otherwise referenced to ARARs or TBCs)

Category / Description	Functional Requirement	Requirement Assessment	Compliance Strategy	Cross Reference Index
EP / Criteria for Air Permits to Operate	OAC 3745-35-02 (C).	No permit to operate will be granted by the State of Ohio until the applicant demonstrates: • The source is in compliance with applicable air pollution control laws; • The source is equipped with instrumentation and sensing devices to monitor and record emission data (if required by the Ohio EPA Director); and • Performance tests were made in accordance with Ohio EPA methods (if required by the Ohio EPA Director).	The AWR air pollution control systems are designed and installed per applicable codes, standards, and regulations. Emission monitoring equipment is provided per 40 CFR 61 requirements (see Exhibit 3-1 ARARs relating to radionuclide emissions). Foster Wheeler is to conduct performance tests of air pollution control systems to demonstrate compliance for Ohio EPA as necessary.	See sections on the RCS and the HVAC Systems of the FRD. Also, see the AWR Project Environmental ALARA Report and Section 2.1, Air Emissions Control, of this ECP for additional information.
EP / Derived Concentration Guides for Radionuclides in Air and in Water	DOE Order 5400.5, Chapter III, Derived Concentration Guides (DCGs) for Air and Water.	The DCG values listed in this chapter are provided as reference values for conducting radiological environmental protection programs at operational DOE facilities and sites.	As previously described, any wastewater resulting from the AWR Project is treated to meet the AWWT WAC, and therefore, achieves compliance with the DCG values for water and the parameters of the NPDES permit for the FEMP site. Also, the RCS controls air emissions to levels such that compliance with the air immersion DCGs are achieved.	See Sections 2.1 and 2.3 of the ECP for additional information.
EW / Ohio Construction Demolition Debris Rule	OAC 3745-400.	Construction and demolition debris shall be disposed of only by the methods listed in OAC 3745-400-04, such as landfilling or other methods approved by the licensing authority.	Construction and demolition debris is staged and stored according to approved AWR SOPs. Temporary management of these materials is performed per the Waste Handling Work Plan. FDF is to provide final disposal of such materials.	See the AWR Project Waste Handling Work Plan for additional information.

000208

31 57

FERNALD AWR PROJECT

Health and Safety Controls -H&S-001-000

May 12, 2000

This document has been reviewed and approved by:

Project Manager: _____ Date: _____

Quality Assurance: _____ Date: _____

Health and Safety: _____ Date: _____

Table of Contents

ACRONYMS AND ABBREVIATIONS.....iii

1.0 PURPOSE.....1

2.0 REFERENCES.....2

Acronyms and Abbreviations

ALARA	as low as reasonably achievable
H&SC	health and safety controls
IHA	Integrated Hazard Analysis
PHAR	Preliminary Hazard Analysis Report
PPE	personal protective equipment
PSHASP	Project-Specific Health and Safety Plan
PSHPP	Project-Specific Health Physics Plan
PSHSRM	Project-Specific Health and Safety Requirements Matrix
SBDIP	Safety Basis Documentation Implementation Plan

1.0 PURPOSE

The Health and Safety Controls (H&SC) section, of the Remedial Design Package, describes the overall process for the development of the safety documentation to support the operations phase of the Accelerated Waste Retrieval (AWR) Project. The H&SC is an upper-tier document that identifies specific AWR documents that detail the preventative measures, safety controls, and actions to be taken to mitigate the consequences of occupational, public and environmental hazards associated with the operations phase of the AWR Project. The flow down documents used to develop the H&SC that are referenced for the AWR Project overall safety process will be revised as the project moves into phases prior to operations.

The AWR Project has five elements that identify the projects preventative measures, safety controls and actions to be taken for occupational hazards. The elements are:

- Overall safety
- Occupational safety
- Radiological safety
- Industrial safety
- Safety implementation

The Safety Basis Document Implementation Plan (SBDIP) (624-P622-47) provides the basis for the establishment of hazard controls necessary for the safe operation of the AWR Project. Hazards for the AWR Project are identified in the Integrated Hazard Analysis (IHA) (624-P622-48). The IHA identifies hazards and accident scenarios, and provides a qualitative evaluation of consequences, probabilities, and the risks from potential accidents from the AWR Project. The IHA is preliminary, and consequences of the potential accidents are analyzed in the project Preliminary Hazards Analysis Report (PHAR) (624-P622-50). The IHA process will continue through final design and will be presented in the Final Hazards Analysis Report.

Occupational safety, for the AWR Project is described in the Project-Specific Health and Safety Plan (PSHASP) (624-P8B21-01). The AWR Project Environmental, Health and Safety/Training Requirements Matrix (EHS/TRM) is an attachment to the PSHASP, that identifies the activities and tasks, potential hazards, monitoring requirements, personal protective equipment (PPE), training, medical monitoring, administrative and engineering controls, permits, and decontamination and disposal procedures. The PSHASP is for the pre-operational, operational, and shutdown and dismantlement phases of the AWR Project. The PSHASP incorporates the results obtained from the PHAR and the IHA. The PSHASP will be revised as the project moves into phases prior to operations.

Radiological Safety for the AWR Project is described and analyzed in the As Low As Reasonably Achievable (ALARA) Plan (624-P622-10) and the ALARA Analysis (624-P622-10A). Implementation of radiological safety is accomplished through the AWR Project Health Physics Plan (HPP) (appendix D to 624-P8B21-01). The HPP will be revised as the project moves into phases prior to operations. The ALARA Plan outlines the major hazards/tasks and assembles the radiation protection requirements and existing radiological conditions that pertain to the AWR Project. The ALARA Analysis analyzes the AWR Project tasks to ensure the process is designed and specified in a manner that will keep workers and co-located worker radiation doses ALARA. The ALARA Analysis will be revised as the project moves into phases prior to operations and will be presented in the Final Hazards Analysis Report.

Industrial safety for the AWR Project is described in two documents. One, the Preliminary Fire Hazards Analysis (624-P622-45) evaluated the AWR Project, in accordance with the proposed design documents, to determine what, if any, design modifications, or enhancements, would be necessary for the fire safety and life safety elements of the project. Two, the Human Factors Evaluation (624-P622-56) assesses a variety of areas important to the safe operation of the AWR Project with the goal of reducing the risk to employees, the public, and the environment due to operator error, by addressing stress, ergonomic, procedural, design, and training issues.

Safety implementation for the AWR Project will be administratively addressed in Safe Work Plans and permits for construction and decontamination and decommissioning. Operating Procedures, the Task Order System and the required Fluor Fernald, Inc. permits will be used during operations.

2.0 REFERENCES

624-P622-47, Safety Basis Document Implementation Plan

624-P8B21-01, Project-Specific Health and Safety Plan

624-P622-48, Integrated Hazard Analysis

624-P622-50, Preliminary Hazard Analysis Report for Silo 1 & 2 AWR Project

624-P622-56, Human Factors Evaluation

624-P622-45, Preliminary Fire Hazards Analysis

624-P622-10A0, ALARA Analysis

624-P622-10, Environmental and Occupational ALARA Plan

624-P8B21-01 (Appendix D), AWR Project Health Physics Plan

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Section 7.0
Contingency Plan

3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CONTINGENCY PLAN AND EMERGENCY RESPONSE

DOCUMENT NO.
624-P621-09, Rev. 0

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

ECDC CONTROLLED
COPY NO. 291

SUBMITTED TO:

FLUOR FERNALD, INC.

CONTRACT NO. FSC 624

[X] A - Conforms to the Subcontract Requirements
[ ] B - Minor Comment - Incorporate and Resubmit
[ ] C - Revise and Resubmit
Sig: _____ Date: 4/25/00

April 19, 2000

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FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CONTINGENCY PLAN AND EMERGENCY RESPONSE
Revision 0

Recommended by:

K. Eger

Foster Wheeler ESQ Manager

4-21-00

Date

Approved by:

W. H. Mackay

Foster Wheeler Project Manager

4/21/00

Date

3157

CONTENTS

1.0 INTRODUCTION 1
- 1.1 Organization, Purpose, and Revision of Plan 1
- 1.2 AWR Project Description and Scope of Work 1
- 1.3 Hazard Survey and Hazards Assessment 3
- 1.4 Contractors 3
- 1.5 Physical Attributes of the Site 4
  - 1.5.1 Geography, Topography and Geology 4
  - 1.5.2 Population Distribution 4
  - 1.5.3 Meteorology 4
  - 1.5.4 Natural Phenomena 6
  - 1.5.5 Transportation, Utility and Security Systems 6

2.0 EMERGENCY RESPONSE ORGANIZATION 7
- 2.1 Organizational Structure 7
- 2.2 Emergency Direction and Control 8
  - 2.2.1 Responsibilities of the Foster Wheeler EC 8
  - 2.2.2 Responsibilities of the Foster Wheeler PM 8
  - 2.2.3 Responsibilities of AWR Project Personnel 9
- 2.3 Emergency Management Operations 9

3.0 OFFSITE RESPONSE INTERFACES 10

4.0 EMERGENCY CLASSIFICATION 11
- 4.1 Definitions 11
- 4.2 Criteria for Operational Emergencies 11

5.0 NOTIFICATIONS AND COMMUNICATIONS 12
- 5.1 Offsite Notifications 12
- 5.2 Onsite Notifications 12
- 5.3 Foster Wheeler Notifications 12
- 5.4 Communications 13

6.0 CONSEQUENCE ASSESSMENT 15
- 6.1 Consequence Determination 15
  - 6.1.1 Severe Weather and Earthquakes 15
  - 6.1.2 Radiological Release 16
  - 6.1.3 Fire 16
  - 6.1.4 Onsite Vehicle Accidents 17
  - 6.1.5 Bomb Threats/Suspicious Devices 17
- 6.2 Continuous Assessment and Coordination 17

7.0 PROTECTIVE ACTIONS AND REENTRY 18
- 7.1 Protection of Onsite Personnel 18
  - 7.1.1 Severe Weather and Earthquakes 18
  - 7.1.2 Radiological Release 20
  - 7.1.3 Fire 21
  - 7.1.4 Onsite Vehicle Accidents 22
  - 7.1.5 Bomb Threats/Suspicious Devices 22
- 7.2 Protection of Offsite Personnel 23
- 7.3 Protective Action Guides (PAGs) 23
- 7.4 Emergency Response Planning Guides (ERPGs) 23
- 7.5 Records 24
- 7.6 Personnel Accountability/Evacuation 24
- 7.7 Reentry 24

7.8 Emergency Planning Zone (EPZ) 24
7.9 Communication 25
7.10 Termination of Protective Actions 25
7.11 Shutdown of Operations 25
8.0 EMERGENCY MEDICAL SUPPORT 26
8.1 AWR Project Site 26
8.2 FEMP Site 26
8.3 Offsite 27
9.0 EMERGENCY TERMINATION AND RECOVERY 28
9.1 Emergency Termination 28
9.2 Recovery 28
9.2.1 Silo Dome Collapse 28
9.2.2 TTA Tank Rupture or Leak 29
10.0 PUBLIC INFORMATION 31
11.0 EMERGENCY FACILITIES AND EQUIPMENT 32
11.1 FEMP Emergency Facilities 32
11.2 FEMP Emergency Equipment 32
11.3 AWR Project Area Emergency Equipment and Facilities 33
12.0 PROGRAM ADMINISTRATION 34
12.1 Emergency Management Program Administrator 34
12.2 Drills, Exercises, and Training 34
12.3 Document Control 35
13.0 REFERENCES 36

APPENDICES

000218

3157

ACRONYMS

AEDO	Fluor Fernald Assistant Emergency Duty Officer
AIHA	American Industrial Hygiene Association
API	American Petroleum Institute
AWR	Accelerated Waste Retrieval
BMP	Best Management Practices
CCTV	closed circuit television
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
DED	Fluor Fernald Deputy Emergency Director
DOE	U.S. Department of Energy
DWRS	Decant Sump Waste Retrieval System
EAL	Emergency Action Levels
EC	Foster Wheeler Emergency Coordinator
EDO	Fluor Fernald Emergency Duty Officer
EMS	Emergency Management System
EMT	Emergency Medical Technician
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ERPG	Emergency Response Planning Guide
ERT	Fluor Fernald Emergency Response Team
ESQ	Environmental Safety and Quality
EVAC	Emergency Voice Alarm and Evacuation
EZ	exclusion zone
FAT&LC	Fernald Atomic Trades and Labor Council
Fluor Fernald	Fluor Fernald, Inc.
FDS	Facilities Decontamination System
FEMP	Fernald Environmental Management Project
FHA	Fire Hazard Analysis
FSM	Full Scale Mock-up
FSMS	Full Scale Mock-up System
FWENC	Foster Wheeler Environmental Corporation
GCBCTC	Greater Cincinnati Building and Construction Trades Council
GET	General Employee Training
HASP	Health and Safety Plan
HazCat	Hazard Category
HAZMAT	hazardous materials
ICAT	Integrated Construction Acceptance Test
INZ	Immediate Notification Zone
JIC	Joint Information Center
LEPC	Local Emergency Planning Committee
LOC	level of concern
mrem	millirem
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
NIS	not in scope
NPDES	National Pollutant Discharge Elimination System

000219

ACRONYMS

OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAG	Protective Action Guide
PCM	personal contamination monitor
PEL	Permissible Exposure Limit
PESM	Project Environmental and Safety Manager
PLC	programmable logic control
PHA	Preliminary Hazards Analysis
PM	Project Manager
PPE	personal protective equipment
QF	quality factor
RCRA	Resource Conservation and Recovery Act
RCS	Radon Control System
RQ	Reportable Quantity
RSO	Radiation Safety Officer
RTS	Radon Treatment System
S&H	Safety and Health
SOT	System Operability Test
STEL	Short-Term Exposure Limit
SWPPP	Storm Water Pollution Prevention Plan
SWRS	Silos Waste Retrieval System
SZ	support zone
TEDE	total effective dose equivalent
TRD	Technical Requirements Document
TSS	Tension Support Structure
TTA	Transfer Tank Area
TWRS	Tank Waste Retrieval System
UL	Underwriters Laboratories
VitPP	Vitrification Pilot Plant

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3157

1.0 INTRODUCTION

This Contingency Plan is prepared for the scope of work activities associated with the Accelerated Waste Retrieval (AWR) Project at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. It addresses the appropriate emergency response requirements contained in DOE Order 151.1 (DOE 1996), and to complement, interface, and reference, as appropriate, the *FEMP Emergency Plan*, PL-3020, Revision Number 4.

Emergency response related to the AWR Project is a shared responsibility between Fluor Fernald, Inc. (Fluor Fernald) and Foster Wheeler. The Fluor Fernald Emergency Response Team (ERT) will implement the FEMP Emergency Plan in response to an emergency situation in the AWR Project area. These situations include, but are not limited to, fire, personnel injury, or spills. The Foster Wheeler Emergency Coordinator (EC) is to inform the Fluor Fernald Emergency Duty Officer (EDO) or the Fluor Fernald Assistant Emergency Duty Officer (AEDO) in the event of an emergency.

1.1 Organization, Purpose, and Revision of Plan

This Contingency Plan is organized similar to *DOE Emergency Management Guide 151.1-1*, Volume V, Operational Emergency Hazardous Materials Program Emergency Plan, with appropriate DOE Order 151.1 guidance provided in quotations at the beginning of each of the following sections of this plan. This Plan is intended to primarily address specific AWR Project area emergency situations, and reference, as appropriate, the FEMP Emergency Plan for further information related to emergency evacuations and notifications. Revisions to the FEMP Emergency Plan need to be evaluated with respect to the contents of this Contingency Plan, and therefore, Foster Wheeler needs to be on controlled distribution of the FEMP Emergency Plan prior to commencement of field activities.

This Contingency Plan is required to be kept current and is the responsibility of the Foster Wheeler Project Manager (PM) to ensure its accuracy over the course of the AWR Project within Foster Wheeler's scope of work. Controlled copies of this Plan are to be distributed among appropriate AWR Project personnel according to AWR Project plans and procedures. Fluor Fernald is responsible for distribution to appropriate FEMP personnel and offsite agencies and response organizations. Emergency response information is also provided in the *Project Specific Health and Safety Plan* (HASP) for the AWR Project (Document No. 624-P8B21-01), and therefore, modifications to this Contingency Plan need to be reviewed concurrently with the Project Specific HASP as well.

1.2 AWR Project Description and Scope of Work

Silos 1 and 2 at the FEMP contain K-65 material, a residue that contains radionuclides, including radium (the primary contaminant of concern), generated from the processing of high-grade uranium ores. Silos 1 and 2 are part of Operable Unit (OU) 4 at the site. The purpose of the AWR Project is to: extract the material from Silos 1 and 2; segregate discrete objects; transfer the residue to transfer tanks for staging prior to final remediation; reduce the radon concentration in each of the silos' headspace; provide radon control during retrieval and material storage; clean the silos and equipment for system closure; and handle secondary waste generated during the AWR Project.

000221

As the contractor to Fluor Fernald for this work, Foster Wheeler is designing, constructing, testing and directing the operation and maintenance of the AWR Project. Fluor Fernald is providing labor for operations and maintenance. The Project consists of four stages:

- **Stage 1.** Radon Control System (RCS) installation, operation, and maintenance to reduce the radon concentration of each of the silos headspace prior to silo retrieval operations;
- **Stage 2.** Demonstration of the Full Scale Mock-up System (FSMS) and residue retrieval from the Transfer Tank Area (TTA) to support future processing (the future silos residue processing facility is not in scope [NIS] for the AWR Contract);
- **Stage 3.** Residue material retrieval from the silos, material segregation, transfer of residue to the TTA, and placement of discrete objects in drums for processing by others; and
- **Stage 4.** Staging and storage of the residue in the TTA.

These stages differ slightly from the stages defined in the *Technical Requirements Document* (TRD) of the AWR Contract, but more accurately reflect Foster Wheeler's approach to managing the AWR Project. The AWR Project includes seven major systems listed below.

- **Silos Waste Retrieval System (SWRS).** The SWRS retrieves material from the silos; transfers residues, BentoGrout™, and heel material to the transfer tanks; retrieves and packages discrete objects; and performs gross decontamination of the silos.
- **Decant Sump Waste Retrieval System (DWRS).** The DWRS retrieves materials from the decant sump (liquids from the silos and approximately 1,000 gallons of sludge/solids in a heel), segregates materials and transfers/packages them, and performs gross decontamination of the decant sump.
- **TTA.** The TTA consists of transfer tanks to be used as a storage area for residues and combined BentoGrout™ for future transfer to the future remediation facility. Provisions will be made for sampling and sample storage.
- **Transfer Tank Waste Retrieval System (TWRS).** In the future, the TWRS will retrieve the residues and combined BentoGrout™ from the TTA and transfer them for processing at a future waste treatment facility (NIS).
- **RCS, Phase 1 and 2.** RCS Phase 1 controls and reduces radon concentrations in the silos headspace. RCS Phase 2 ensures radon control during retrieval, transfer, and storage of the silos material.
- **FSMS.** A Full Scale Mock-up (FSM) Integrated Construction Acceptance Test (ICAT)/ System Operability Test (SOT) is to be performed with the Silo 4 FSMS. Foster Wheeler will incorporate the lessons learned from the FSM ICAT/SOT into the AWR Project prior to beginning operations and use the FSMS for training and troubleshooting during SWRS operations.

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- **Facilities Decontamination System (FDS).** The Facilities Decontamination System functions to remove gross contamination from the silos, decant sump tank, and contaminated process equipment as part of facility demobilization and closure. Two categories of gross decontamination activities are provided by the FDS. First, the gross decontamination of silos, decant sump tank, and process equipment, as well as permanent facilities erected during the project is part of the FDS. The second type is decontamination of temporary tools, equipment, and facilities used on the project.

Upon completion of the AWR Project, material from Silos 1 and 2 will have been conveyed to transfer tanks for staging prior to final remediation; discrete objects will have been segregated and disposed; and the silos will have undergone gross decontamination. As a result, K-65 residue material is stored in a stable configuration (with radon control) awaiting ultimate disposition.

1.3 Hazard Survey and Hazards Assessment

Hazard Category Calculations have been prepared to quantify the risk of potential hazards associated with the construction and operation of the AWR Project and to confirm that the hazards are correctly categorized. As described in the *Hazard Category Calculations*, Document No. 624-P622-49, for the AWR Project, the most significant (bounding) hazard from the Preliminary Hazards Analysis (PHA) is the "loss of silo containment" as a result of the collapse of a silo dome or other major breach of a silo dome. The radon in the headspace may be released instantaneously in a puff release, followed by a continuous (but lower concentration) release of radon on the basis of the emanation rate from the waste in the silo.

The loss of silo integrity for either Silo 1 or 2 would result in the immediate release of approximately 14 or 18 curies, respectively, of radon and its decay products. A bentonite clay covering placed over the residues initially lowered the headspace radon inventory and minimized the potential for generating airborne releases. However, the clay covering is drying and cracking, and its effectiveness is diminished. The releasable radon inventory in each silo headspace is increasing and may eventually exceed 30 curies.

The calculation results, as presented in Document No. 624-P622-49, confirm that the releasable inventory of either or both silos exceeds the Hazard Category (HazCat) 3 threshold, but does not exceed the HazCat 2 threshold. Thus, the silo facilities and the AWR Project facilities are defined as HazCat 3 facilities.

1.4 Contractors

Foster Wheeler, and its subcontractors, are performing AWR Project work for Fluor Fernald under Contract No. FSC 624. The *Project Management Plan*, Document No. 624-P621-01, describes the Foster Wheeler and Fluor Fernald interfaces for the AWR Project. Other contractors are performing work in areas adjacent to the AWR Project work site. These areas include the Waste Pit Remedial Action Project, the Silo 3 Waste Project, and the OU 2 Haul Road Project. Foster Wheeler is to participate in Fluor Fernald work coordination meetings and will coordinate any interference with another contractor through Fluor Fernald.

1.5 Physical Attributes of the Site

This section provides a brief overview of some of the physical attributes of the FEMP site (including the Silos Area) and its local surroundings. These features or physical attributes are

discussed since they can impact decisions related to emergency planning, preparedness, and response. They include geography, topography, geology, population distribution, meteorology, natural phenomena such as tornados, earthquakes and excessive precipitation events, and transportation and utility systems.

1.5.1 Geography, Topography and Geology

Geography. The FEMP is located on 1,050 acres in a rural area of the southwestern Ohio counties of Hamilton and Butler, near the Indiana border (see Exhibit 1-1). Scattered residences and villages such as Fernald, New Baltimore, New Haven, Ross, and Shandon are located near the FEMP. Downtown Cincinnati is approximately 18 miles southeast of the FEMP, and the cities of Fairfield and Hamilton are 6 and 8 miles to the northeast, respectively (Fluor Fernald 1999). The silos are located at the western edge of the FEMP site (also see Exhibit 1-1).

Topography. The FEMP site is situated on a relatively level plain, about 580 feet above sea level. The land rises to 698 feet at the northern boundary, and slopes downward to 550 feet at Paddy's Run, which is a small creek on the western boundary running roughly north to south through the FEMP. The site is located within the Great Miami River drainage basin. Storm water from the FEMP flows to the Great Miami River primarily via Paddy's Run. The Silos Area is above the 2,000-year floodplain (Fluor Fernald 1998). Storm water runoff from the Silos Area is appropriately controlled and discharged in accordance with the requirements of the FEMP's National Pollutant Discharge Elimination System (NPDES) permit.

Geology. The FEMP is located in the ancestral valley of the Great Miami River. This valley is about 2 miles wide at the FEMP, with the floor about 200 feet below the present topography. The geology of the FEMP and its surrounding areas can be divided into three primary stratigraphic units: the bedrock, the sands and gravels of the Great Miami Aquifer, and the unconsolidated glacial overburden deposits. All of these geologic units occur within the FEMP boundaries to some degree (Fluor Fernald 1998).

1.5.2 Population Distribution

The residential population within a 5-mile radius of the FEMP includes approximately 22,900 people. The heaviest population concentration lies in a corridor extending east-northeast to the southeast of the FEMP. Daytime residential/employment population within a 5-mile radius of the center of the FEMP was approximately 17,900 in 1990 and increases to approximately 21,250 when enrollment of the schools in the area is included. However, the current site population varies daily due to temporary labor forces (Fluor Fernald 1998).

1.5.3 Meteorology

In 1998 the precipitation measured at the FEMP was over 48 inches, which is above the average annual precipitation of almost 41 inches for 1948 through 1997. The prevailing winds at the site during 1998 were from the west through south-southwest approximately 30 to 40 percent of the time, measured at both the 33-foot and 197-foot levels above the ground surface (Fluor Fernald 1999). The average monthly wind speeds range from seven miles per hour (mph) in August to 11 mph in March (Fluor Fernald 1998).

000224

3157

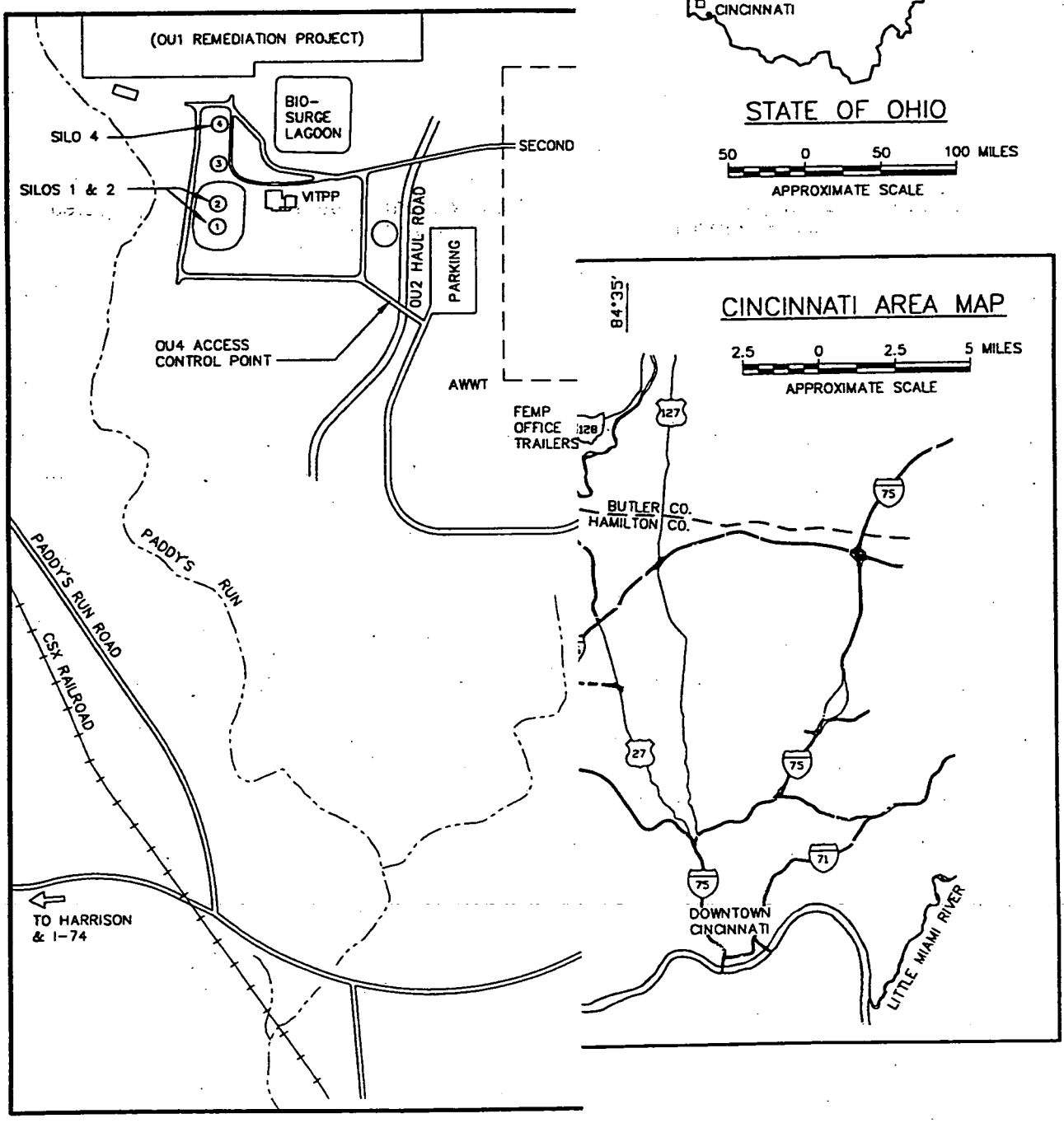

Exhibit 1-1. FEMP Site and Vicinity

3157

1.5.4 Natural Phenomena

Tornado. An annual probability of tornado occurrence per square mile within Ohio was calculated to be 1.25×10^{-4} for the years 1978 through 1990 (Fluor Fernald 1998).

Earthquake. On a scale of less than one to four, a seismic risk zone (measurement of earthquake intensity) of two has been assigned to the FEMP. The historical record of seismic events and the absence of post-Wisconsin faults show that significant damage of local earthquakes at the FEMP is highly unlikely (Fluor Fernald 1998). The Design Basis accident used for new facilities at FEMP is based on an exceedance probability of 1×10^{-3}.

Precipitation. The highest 24-hour rainfall event on record occurred in March 1964, when approximately 5 inches fell. The highest monthly record of snowfall was approximately 32 inches and occurred in January 1978. The recorded maximum snowfall over a 24-hour period occurred in March 1968, when approximately 10 inches were recorded (Fluor Fernald 1998).

1.5.5 Transportation, Utility and Security Systems

A railroad spur serves the FEMP from the CSX Transportation line that runs along the site's western border. Ohio Route 128 runs north and south near the eastern boundary, while Ohio Route 126 runs east and west at the north boundary line (Fluor Fernald 1999). Public access is controlled through the north and south access points at the FEMP site.

The Silos Area utility distribution systems include electrical power and fire protection water. Electrical power for the Silos Area loads is distributed from a substation west of Silo 3 (Fluor Fernald 1998). Fire protection water is provided in the Silos Area via an 8-inch non-looped fire main that ties into the existing 12-inch underground site fire water header. Four hydrants are located in the area to assist fire protection. Each hydrant is capable of delivering 1,000 gallons per minute of water at a residual pressure of not less than 10 pounds per square inch (Fluor Fernald 1998).

Security systems in the Silos Area include fencing, gates, and video cameras. Perimeter fencing and locked gates are used to restrict unauthorized access to the site. Two video cameras are located on the north and south sides of Silos 1 and 2. These cameras allow visual surveillance of the silos domes from the communication center manned by Fluor Fernald personnel.

000226

2.0 EMERGENCY RESPONSE ORGANIZATION

"This organization shall be established and maintained for each site/facility with overall responsibility for the initial and ongoing response to and mitigation of an emergency..."

2.1 Organizational Structure

The Foster Wheeler individual ultimately responsible for emergency planning, preparedness, and response is the AWR Project Environmental Safety and Quality (ESQ) Manager; however, the Foster Wheeler EC, as described in Section 2.2.1, has the day-to-day responsibilities of emergency direction and control prior to Fluor Fernald arrival at the AWR Project site. The AWR Project ESQ Manager, although not located onsite, oversees the preparation of and recommends approval of this Contingency Plan and performs assessments to determine that this Plan is in effect and that pre-emergency requirements are met. He also acts as a liaison to Fluor Fernald regarding regulatory issues and notifies the Occupational Safety and Health Administration (OSHA) of reportable accidents, as described in Section 5.1 of this Contingency Plan.

As depicted in Exhibit 3-2 of the *Project Management Plan* (Document No. 624-P621-01) for the AWR Project, safety and health, radiation safety, and quality are line management responsibilities. The Site Safety and Health (S&H) Representative, the Radiation Safety Officer (RSO), and the Quality Manager support line management in establishing and maintaining safety, radiological control, and quality control programs. They report, functionally, to the Foster Wheeler PM, but to prevent any potential for conflict of interest, these personnel report directly to Foster Wheeler's AWR Project ESQ Manager.

During the construction and operations/maintenance/systems closure phases of the AWR Project, principal work activities are to be performed within the Silos Area at the FEMP site. Construction activities are to be performed by Greater Cincinnati Building and Construction Trades Council (GCBCTC) personnel and managed by the Foster Wheeler Construction Manager. The Foster Wheeler Project Field Engineer is present at the site to assist and provide technical support for construction activities. Operations/maintenance/system closure activities are to be directed by Foster Wheeler and performed by Fernald Atomic Trades and Labor Council (FAT&LC) personnel and managed by the Operations/Maintenance/Systems Closure Manager.

The primary interface between Fluor Fernald and FWENC is between Foster Wheeler's AWR Project Manager and the Fluor Fernald Project Manager, although, for contractual issues the Fluor Fernald Contract Administrator communicates directly with the Foster Wheeler PM. Working interfaces also exist at the manager level. The primary construction interface is between Fluor Fernald's Construction Contracts Manager and Foster Wheeler's Construction Manager. The primary operations and maintenance interface (including systems closure) is between Fluor Fernald's Operations Maintenance Manager (or the appointed maintenance supervisor) and Foster Wheeler's Operations/Maintenance/Systems Closure Manager. The primary safety interface between Foster Wheeler and Fluor Fernald is established to work critical issues over the course of the AWR Project. This safety interface is between Fluor Fernald's S&H Manager and Foster Wheeler's ESQ Manager.

The management of the craft labor for construction is a cooperative effort between the Foster Wheeler Management Team and the GCBCTC Craft Foremen. The Craft Foremen are utilized as the liaison between the Foster Wheeler Supervisory and Management personnel and the

3157

GCBCTC personnel. Fluor Fernald Team Leaders have the responsibility for managing FAT&LC personnel. Fluor Fernald Team Leaders are utilized as the liaison between the Foster Wheeler Supervisory and Management personnel and the FAT&LC personnel.

2.2 Emergency Direction and Control

This section describes the responsibilities of various AWR Project personnel regarding emergency direction and control in the event of an emergency at the AWR Project site. As previously mentioned, emergency response related to the AWR Project is a shared responsibility between Fluor Fernald and Foster Wheeler. The Fluor Fernald ERT will implement the *FEMP Emergency Plan* in response to an emergency situation in the AWR Project area. The Foster Wheeler EC is to inform the Fluor Fernald EDO or the Fluor Fernald AEDO in the event of an emergency.

2.2.1 Responsibilities of the Foster Wheeler EC

The Senior Shift Supervisor (during the construction phase) or the Shift Supervisor on duty (during the operations/maintenance/systems closure phase) serves as the Foster Wheeler EC for the AWR Project. The Foster Wheeler EC is required to immediately notify the Fluor Fernald EDO or AEDO and AWR Project personnel in the event of an emergency. The Foster Wheeler EC is also responsible for personnel safety and machinery and processes in the event of an emergency or a stop work order prior to Fluor Fernald arrival.

In the event of an emergency at the AWR Project site, the Foster Wheeler EC reports immediately to the scene of the emergency to assess the seriousness of the situation and immediately notifies the Fluor Fernald EDO or AEDO and the Foster Wheeler PM. The Foster Wheeler EC then directs whatever efforts are necessary until the Fluor Fernald ERT arrives. At his discretion, the Foster Wheeler EC may also order closure of the AWR Project site for an indefinite period.

The Foster Wheeler EC responsibilities during an emergency situation include:

- Informs the Fluor Fernald AEDO of existing conditions and cooperates with the AEDO to resolve the emergency situation,
- Directs the activities of AWR Project personnel in emergency situations, including assigning employee/alternate to turn off equipment and utilities, and other related tasks in the event of an emergency shutdown, until the Fluor Fernald AEDO arrives,
- Provides for assistance of physically challenged employees during evacuations, as necessary, and
- Conducts a Rally Point headcount, or designates an alternate to do so, when the AWR Project area is evacuated.

000228

In addition, the Foster Wheeler PM, the Construction Manager, or the Operations/Maintenance/ Systems Closure Manager may assume the responsibilities of the Foster Wheeler EC upon arrival at the scene.

2.2.2 Responsibilities of the Foster Wheeler PM

Throughout all project phases, the Foster Wheeler PM has complete authority and responsibility for Foster Wheeler and subcontractor personnel performance. The PM ensures that Foster Wheeler resources are available and committed to emergency response at the AWR Project site. The PM also notifies the Foster Wheeler corporate ESQ Manager and the Vice President of Remediation in the event of an emergency:

2.2.3 Responsibilities of AWR Project Personnel

Each AWR Project person has the following responsibilities related to emergency response actions to be taken during abnormal situations at the AWR Project site:

- Notifies nearby personnel to evacuate dangerous areas in the event of an emergency,
- Proceeds in accordance with this Contingency Plan in emergency situations,
- Responds to emergency signals, and
- Supports the Foster Wheeler EC and the Fluor Fernald EDO or AEDO as necessary.

2.3 Emergency Management Operations

Emergency response related to the AWR Project is a shared responsibility between Fluor Fernald and Foster Wheeler. The Fluor Fernald ERT will use the *FEMP Emergency Plan* and related emergency procedures in response to an emergency situation in the AWR Project area. These situations include, but are not limited to, fire, personnel injury, or spills. The Foster Wheeler EC is to inform the Fluor Fernald EDO or the AEDO in the event of an emergency. Fluor Fernald emergency management operations at FEMP are implemented according to the *FEMP Emergency Plan.*

000229

3.0 OFFSITE RESPONSE INTERFACES

3157

"Coordination with State, Tribal, and local agencies and organizations responsible for offsite emergency response and for protection of the health and safety of the public..."

Foster Wheeler may support Fluor Fernald in external communications, however, communications for the AWR Project related to emergency response notifications with outside individuals, agencies, or other stakeholders must go through Fluor Fernald, as depicted in Exhibit 3-1. When implemented, the *FEMP Emergency Plan* is used as the basis for offsite response interfaces for the FEMP site.

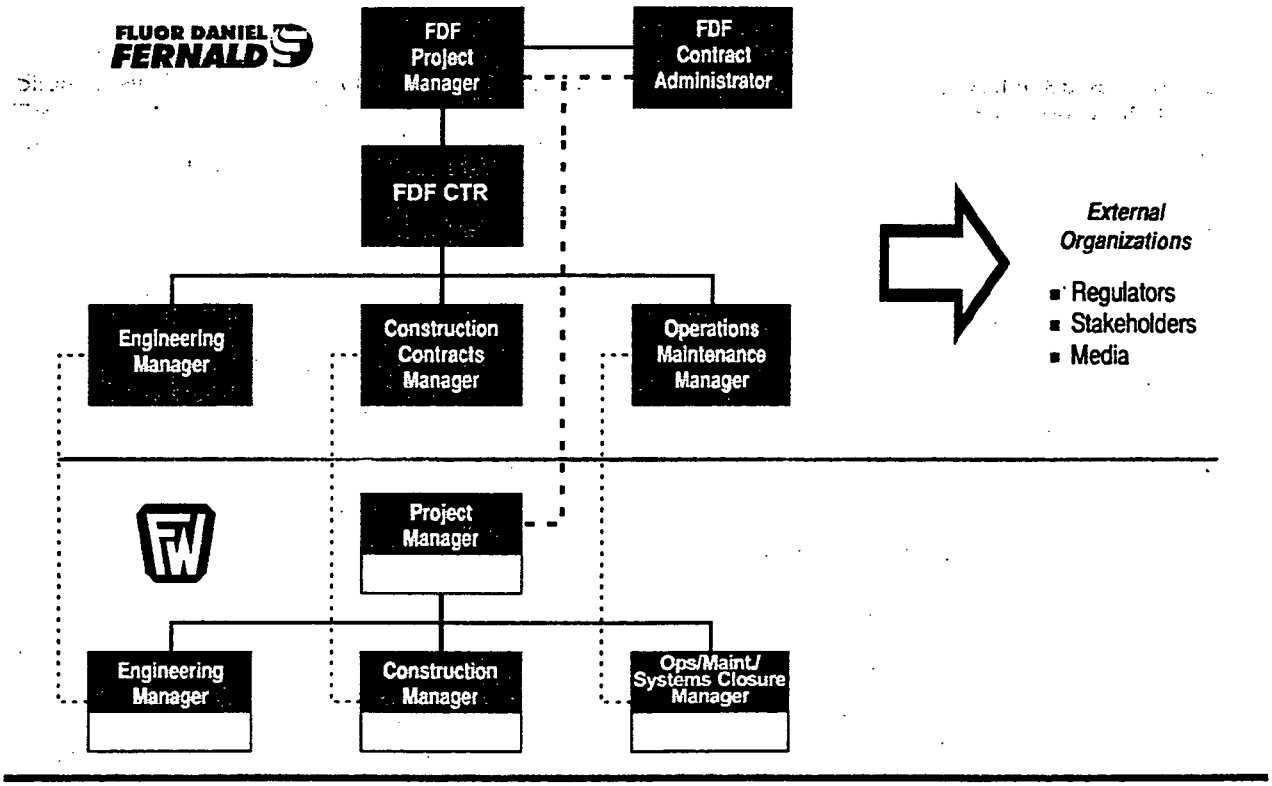

Exhibit 3-1. AWR Project Interfaces

(Note: Fluor Daniel Fernald (FDF) is the equivalent of Fluor Fernald for use in this exhibit.)

The FEMP maintains mutual aid agreements with local authorities for fire, ambulance, law enforcement, and medical services. The Fluor Fernald AEDO, with assistance of Fluor Fernald division commanders, determines the need to invoke these agreements during an emergency (Fluor Fernald 1999).

000230

4.0 EMERGENCY CLASSIFICATION

"Provisions shall be established to categorize and classify emergency events..."

Classification aids in the rapid communication of critical information and the initiation of appropriate time-urgent emergency response actions. The *FEMP Emergency Plan* defines the emergency categories that are applied to the FEMP site as well as the AWR Project. The Fluor Fernald EDO or AEDO will classify each emergency based on information provided by the Foster Wheeler EC and other sources of information available.

4.1 Definitions

Events that operationally involve or effect the FEMP are grouped into four categories, by relative ranking of status, to ensure that the urgency of notification is readily identifiable and appropriate response actions are directed immediately. The four categories in order of increasing severity are defined as follows:

- ***Loggable Event*** – Non-routine event not significant enough to warrant reporting to any outside agency, but is documented for trend or other analysis.

- ***Off-Normal Occurrence*** – Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in the safety, security, environmental or health protection performance or operation at a facility.

- ***Unusual Occurrence*** – A non-emergency occurrence that has significant impact or potential for impact on safety, environment, health, security or operations of a facility.

- ***Operational Emergency*** – An unplanned, significant event or condition that requires time-urgent response from outside the immediate/affected site/facility or area of the incident. Such events are included in the *FEMP Emergency Plan* but may also be classified as a Level I Emergency Condition Level under criteria established by Local Emergency Planning Committee (LEPC) guidance.

4.2 Criteria for Operational Emergencies

An operational emergency shall be declared when events occur that represent a significant degradation in the level of safety at a site/facility and that require time-urgent response efforts from outside the site/facility. Operational emergencies shall be further classified as either an Alert, Site Area Emergency, or General Emergency (in order of increasing severity) when events occur that represent a specific threat to workers and the public due to the release or potential release of significant quantities of radiological/non-radiological hazardous materials. FEMP general emergency response procedures to operational emergencies are summarized in Emergency Action Level (EAL) Guides (see Appendix A to this Contingency Plan).

During off-normal events, Fluor Fernald will take over control of the AWR Project work area and implement appropriate actions, with direct input from the Foster Wheeler. The Fluor Fernald EDO or AEDO and the ERT then direct the appropriate emergency actions at the remainder of the site. Foster Wheeler will also notify Fluor Fernald of unplanned, non-life threatening events such as a pipe or valve leak. For additional discussion regarding notifications, see Section 5.0 of this Contingency Plan.

5.0 NOTIFICATIONS AND COMMUNICATIONS

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"Provisions shall be established for prompt initial notification of workers and emergency response personnel and organizations..."

5.1 Offsite Notifications

The Foster Wheeler EC shall notify the Fluor Fernald EDO or AEDO in the event of an emergency, in which the Fluor Fernald ERT will provide emergency response at the AWR Project site. The AEDO and EDO assess and categorize/classify the event. Fluor Fernald records all events in a daily log, and the appropriate notifications and reports made for only those events categorized as Off-Normal Occurrences or higher.

In the event of an emergency at the FEMP site, all offsite notifications are handled by Fluor Fernald and DOE in accordance with the *FEMP Emergency Plan*, except in cases of a fatality or catastrophe in which three or more workers are injured and hospitalized. In these cases, the Foster Wheeler EC is required to notify the AWR Project ESQ Manager immediately, and the AWR Project ESQ Manager is required to notify OSHA in accordance with Foster Wheeler corporate procedures.

5.2 Onsite Notifications

The Foster Wheeler EC is required to notify the Fluor Fernald EDO or AEDO in the event of an emergency. These notifications will be made either by radio, telephone, or pager.

> ***NOTE: In an emergency situation, the health and safety of an employee takes precedence over radiological controls.***

Radiological incidents or abnormal events shall be immediately reported to Fluor Fernald. Examples include, but are not limited to, skin or clothing (other than personal protective equipment [PPE]) contamination, situations where radioactive material uptake is suspected and situations where contamination is spread to a controlled area or clean area. If such an event occurs, then the Foster Wheeler EC (or designee) shall document the event or condition in writing. This documentation shall include enough information to reconstruct the event, its associated consequences, corrective or recovery actions, and the estimated dollar amounts of damage to property or cost of the corrective actions taken.

5.3 Foster Wheeler Notifications

As soon as first aid and/or emergency response needs have been met, the following Foster Wheeler personnel are to be contacted by telephone:

- Project Manager,
- Project S&H Representative,
- Project RSO (for radiological events), and
- The employer of any injured worker who is <u>not</u> a Foster Wheeler employee.

000232

Written confirmation of verbal reports are to be submitted within 24 hours. The Foster Wheeler accident/incident report forms are provided in Appendix B to this Contingency Plan. If the employee is not a Foster Wheeler employee, then his employer will also receive a copy of the report.

5.4 Communications

The FEMP maintains a communications system to ensure adequate control over both normal plant operations and emergency operations. The communications used for the AWR Project will be compatible and tie into the FEMP system. The following types of communications will be used at the AWR Project site in the event of an emergency:

- **Evacuation Alarms** – Local evacuation alarms are provided in the Vitrification Pilot Plant (VitPP) Control Room for the AWR Project. These alarms can be activated if the RCS stack alarm or TTA secondary containment leak detection alarms are activated. All emergency voice and evacuation alarm devices will be compatible with the FEMP Honeywell Emergency Voice Alarm and Evacuation (EVAC) System, with the master control at the FEMP Emergency Operations Center (EOC).

- **Fire Detection and Annunciation** – Foster Wheeler will provide and connect an emergency alarm system that complies with National Fire Protection Association (NFPA) 72-1999 and is compatible with the existing FEMP Honeywell Delta 1000, Environmental and Fire and Safety Alarm System. Also, manual fire alarm stations, audible and visual fire alarm notification devices, smoke detection alarms (for indoor locations), and monitors/alarms for automatic sprinkler systems (if used) will be appropriately located at the AWR Project site. These alarms will be tied into the FEMP sitewide alarm system so that all emergency alarms report to and terminate in the FEMP EOC.

- **Telephones** – Telephones will be located at the AWR Project support trailers in the support zone (SZ) for communication with emergency support services/facilities. Several cellular telephones and pagers will be issued to AWR Project personnel responsible for emergency communications to provide backup capabilities. To report emergencies onsite by phone, dial 911, or from a cellular phone dial 648-6511. These numbers will be posted at the AWR Project site.

- **Radios** – The primary form of communication during an emergency between field groups in the exclusion zone (EZ) and the Foster Wheeler EC will be radio communications. Each field team within the EZ shall have a two-way radio. **One site radio is required for the express purpose of emergency contact.** During an emergency situation, the lines will be kept clear so that all field teams can receive instructions. The use of radios for the AWR Project will be coordinated with FEMP Site Security and the current FEMP-maintained short-range, government-frequency FM radios. To report emergencies onsite by radio, switch to Channel 7 and call CONTROL. This number will be posted at the AWR Project site.

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- **Hand Signals** – Hand signals along with the buddy system shall be used by field teams. The entire field team shall know these signals before operations commence and their use covered during site-specific training. Typical hand signals include the following:

Hand Signal	Meaning
Hand gripping throat	Out of air, can't breathe.
Grip on partner's wrist or place both hands around partner's waist	Leave the area immediately. No debate.
Hands on top of head	Need assistance.
Thumbs up	Okay. I'm all right. I understand.
Thumbs down	No. Negative.

000234

6.0 CONSEQUENCE ASSESSMENT

"Provisions shall be established to adequately assess the potential or actual onsite or offsite consequences of an emergency..."

6.1 Consequence Determination

As part of the initial assessment after being notified of an emergency event, the Foster Wheeler EC will assist the Fluor Fernald AEDO, as requested, in data gathering, evaluation of critical factors, and the development of a Tactical Attack Plan for the particular event. Emergency planning at the FEMP is based on detailed hazard and safety analyses, when available, and best engineering judgment for those accidents in which detailed analyses have not been completed. This judgment considers the potential consequences of the event and the probability for that event to occur.

The following events, adapted from the *FEMP Emergency Plan*, are to be considered for emergency planning purposes related to the AWR Project, along with general mitigation measures related to the events. Protective actions and further detail of mitigation measures for these events are summarized in Sections 7 and 9 of this Contingency Plan.

6.1.1 Severe Weather and Earthquakes

Severe weather is the most likely event to occur at the FEMP with tornados presenting a significant enough hazard to warrant the declaration of an emergency. Severe thunderstorm warnings (winds expected at or above 50 knots) occur several times a year and tornados have historically occurred in the vicinity. Personal injury and property damage may result from high winds, differential pressure, or missiles produced by high winds. In severe cases, the integrity of buildings or containers (including Silos 1 and 2 and the TTA tanks) containing hazardous or radiological material may be compromised resulting in a release.

In the event of adverse weather conditions, the Site S&H Representative or designee will work with Fluor Fernald S&H personnel to determine if work can continue without potentially risking the safety of field personnel. Some of the items to be considered include:

- Potential for heat stress and heat-related injuries,
- Potential for cold stress and cold-related injuries,
- Treacherous weather-related working conditions such as hail, rain, snow, ice, high winds, etc.,
- Limited visibility (fog), and
- Potential for electrical storms.

000235

3157

Site activities will be limited to daylight hours or when suitable artificial light is provided, and when acceptable weather conditions prevail. The Site S&H Representative (or designee) will work with Fluor Fernald S&H personnel to determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

The FEMP is located in a seismic zone where earthquakes do occur periodically. A severe earthquake would result in significant property damage, and could result in mass casualties and disruption of the entire community. The FEMP site could be isolated from additional assistance, especially during the initial hours after such an event. Damage to the silos or AWR Project facilities could cause a radiological release.

6.1.2 Radiological Release

Silos 1 and 2 currently contain residues from earlier site processing activities and a Radon Treatment System (RTS) for removing radon gas that collects in the dome area of the silos. (Note: The RTS is not currently operating and has been disconnected from the silos). As part of the AWR Project, radon from the silos and the new TTA will be collected and treated at the site using the RCS. In addition, a TTA tank or transfer line rupture/ leak would be contained within the secondary containment of the TTA system, with radon collected by the RCS.

The draft *FEMP Hazard Assessment* considered the failure mechanisms including loss of containment (i.e., partial or full dome collapse) due to natural degradation, earthquake, and dome collapse due to high winds. Of these events, loss of containment due to natural degradation is the bounding event for probability of occurrence; however, dome collapse due to earthquake is the bounding event for onsite/offsite consequences (Fluor Fernald 1999a). The worst case for dome collapse due to an earthquake is projected to result in an exposure at the facility boundary of greater than 100 mrem but less than 1 rem total effective dose equivalent (TEDE). This exposure would exceed the decision criteria for an Alert level at the FEMP. Assessment of the need for categorization based on airborne concentrations of radiological isotopes will be made based on actual, measured airborne concentrations for specific isotopes (Fluor Fernald 1999a).

6.1.3 Fire

Potential sources of fire do exist during construction and operations related to the AWR Project. These may include welding, abrasive cutting, lightning strikes, electrical or office accidents, etc. A *Fire Hazard Analysis* (FHA) for the AWR Project (Document No. 624-P622-45) comprehensively and qualitatively assesses individual fire areas and whether applicable DOE Orders are met and that the acceptable level of protection is being incorporated into the design. Adhering to the following precautions can potentially prevent fires:

- Good housekeeping and storage of materials,
- Storage of flammable liquids and gases away from oxidizers,
- No smoking in the EZ or any work area,

000236

- No hot work without a properly executed hot work permit,
- Shutting off engines and allow engines to cool before refueling (Fluor Fernald 1999c),
- Grounding and bonding metal containers during transfer of flammable liquids,
- Use of Underwriters Laboratories (UL) approved flammable storage cans,
- Fire extinguishers, rated at least 10 pounds ABC, located on heavy equipment, in trailers, and near hot work areas, and
- Monthly inspections of fire extinguishers.

6.1.4 Onsite Vehicle Accidents

Vehicle accidents occurring onsite can result in injuries and property damage. Restricted roadways and enforced low speed limits reduce the hazard potential of a vehicle accident onsite. Offsite transportation accidents are addressed in the *FEMP Emergency Plan.*

6.1.5 Bomb Threats/Suspicious Devices

The degradation of safety and security to AWR Project personnel and property by the threat of an explosive or suspicious device is always a possibility. Personnel are to respond conservatively to bomb threats (including biological/chemical threats) and the discovery of suspicious devices.

6.2 Continuous Assessment and Coordination

An initial assessment of an incident is performed by the Fluor Fernald AEDO, with assistance from Foster Wheeler as required, and developed into a tactical attack plan to resolve the incident. When activated, the FEMP EOC can perform a more comprehensive assessment. As events unfold, the situation is reassessed with input from the field teams and the EOC staff.

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7.0 PROTECTIVE ACTIONS AND REENTRY

"Protective actions shall be predetermined for onsite personnel and the public..."

7.1 Protection of Onsite Personnel

The primary methods to protect onsite personnel in emergency situations are notification, sheltering, and evacuation. When an emergency occurs, the Foster Wheeler supervisor may direct sheltering or evacuation of AWR Project personnel in the immediate work area. The nearest permanent shelter for the Silos Area is the VitPP, which currently has been designated as the emergency shelter for the Silos Area. Further evacuation and protective actions are governed by implementation of the *FEMP Emergency Plan*. Appendix C to this Contingency Plan provides an area map indicating the AWR Project site personnel evacuation routes and FEMP Rally Point locations (primary and alternate) to be used in the event of an emergency. The general locations of emergency equipment and facilities and equipment for the AWR Project are also noted on the Appendix C area map.

Once the Foster Wheeler EC notifies the Fluor Fernald AEDO and the initial incident assessment has been conducted, the AEDO directs onsite protective actions. Once the Fluor Fernald EDO is briefed or the FEMP EOC activated, they will assume primary responsibility for recommending onsite protective actions and implement the *FEMP Emergency Plan*. Also, FEMP Site Procedure EM-0004, *Protective Actions*, is implemented in the case of radiological and non-radiological releases and is used by Fluor Fernald in determining the appropriate emergency class, affected area, and protective actions for onsite and offsite personnel.

7.1.1 Severe Weather and Earthquakes

Sheltering is the preferred action for tornados, severe weather emergencies, and earthquakes. In this sense, sheltering is defined as moving personnel into permanent buildings or shelters and out of temporary buildings or trailers. As previously mentioned, the emergency shelter for the Silos Area is the VitPP.

Severe Weather. When the announcement of severe weather approaching is made, do **ONE** of the following:

- **WARNING: AVOID WORKING IN HAZARDOUS SITUATIONS SUCH AS HIGH, UNPROTECTED AREAS OR AREAS WHERE MATERIALS MAY BE BLOWN BY WIND.**
- If in an isolated area, then secure equipment/material and leave the area.
- If in an external storage area, then secure loose materials (e.g., empty drums and boxes) by tying, weighing down, reducing stack height, or sheltering; and move into a permanent structure such as the VitPP.
- If outside, then secure equipment/material and move into nearest permanent structure.

000238

- If in a trailer, smoking shelter, or Tension Support Structure (TSS), then seek shelter in nearest permanent structure such as the VitPP.
- If in a permanent structure, then do the following:
  - ✓ Close and secure windows, doors, other openings in which wind or rain could enter,
  - ✓ Move away from windows,
  - ✓ Shut down equipment that is unsafe to operate during wind or rainstorm,
  - ✓ Move valuable equipment and materials to a sheltered location, and
  - ✓ Cover equipment that cannot be moved but may be damaged.

Earthquakes. In the event of an earthquake, AWR Project personnel will be evacuated and sheltered. **WARNING: RESPONSE SHALL BE IMMEDIATE. DO NOT WAIT FOR INSTRUCTIONS.** Back-up communications and a highly survivable FEMP Mobile EOC operated by Fluor Fernald ensure command and communications capabilities during such an event.

The following steps shall be taken in event of an earthquake:

- Take shelter under a sturdy desk or table. If a desk or table is not available, then go to a supported doorway.
- If possible, kneel down, bend head close to knees, cover sides of head with elbows, and clasp hands firmly behind neck.
- Avoid walls, shelves, and glassed areas. If inside, then do not evacuate while tremors are occurring.
- If outside, then move to an open area away from power lines, piping, buildings, and kneel or lie down.
- After the shock has subsided, then evacuate the facility. **(NOTE: Do not use elevators following an earthquake.)**
- While evacuating, move away from structures, avoid electrical wires, broken/leaking pipes, visible fumes, and other hazards that may be encountered.
- Assemble at Rally Point #4 (see Appendix C to this Contingency Plan) or as directed by the Foster Wheeler EC.

000239

3157

7.1.2 Radiological Release

Possible indications of a radiological release in the Silos Area, as adapted from FEMP Site Procedure EM-0030, *Silos Area Emergency Procedure* (Fluor Fernald 1999b), include the following:

- Visual verification during routine inspections of AWR Project operations,
- Visual verification by installed cameras providing surveillance of Silos 1 and 2,
- Abnormally high radon levels as indicated by the continuous environmental radon monitors surrounding the EZ, or
- Activation of remote RCS stack alarms or TTA leak detection alarms.

Silo Dome Collapse. In the event of a silo failure, the *Silos Area Emergency Procedure*, FEMP Site Procedure EM-0030, would be implemented immediately to provide protection to the workforce (Fluor Fernald 1997b). Initial emergency actions, adapted from Site Procedure EM-0030, are summarized below:

- Cease Silos Area operations,
- Notify personnel in immediate area,
- Activate local evacuation alarms from the VitPP control room,
- Evacuate the area **(NOTE: When an emergency occurs and evacuation is ordered, personnel will bypass the personal contamination monitors [PCMs]),**
- Proceed to Rally Point #4,
- Notify the Facility Owner or designee of the event and its estimated magnitude, and
- Notify the AEDO.

Potential recovery actions are described in *Operable Unit 4 (OU4): An Analysis of Emergency Recovery Actions – Phase II* (Fluor Fernald 1998c) and are summarized in Section 9 of this Contingency Plan.

TTA Tank Rupture or Leak. Possible indications of a TTA tank rupture or release are detected primarily by way of either (1) indications from the level instruments in the containment sump, or (2) visual indication via the closed circuit television (CCTV) system.

000240

The following steps are the initial emergency actions to be performed in the event a TTA tank leak is detected:

1. Stop transfer of material from the silos. This action occurs automatically via the Programmable Logic Control (PLC) system if the containment sump leak detection system alarms.

2. Perform a radon survey on the TTA deck first, and then survey around the base of the TTA. If a tank leak has occurred, then some radon (in proportion to the fraction of the waste leaking) will be released to the TTA plenum, and may escape from the plenum even though the penetrations to the TTA deck are sealed. Since no penetrations are located in the shield wall of the TTA, minimal radon leakage would occur through the sides.

3. Control personnel access to the TTA area based on the results of the surveys described above.

4. Ascertain which tank is leaking by use of the CCTV and by monitoring the tank level indicators.

5. If openings are detected between the plenum and TTA deck, then seal with foam or caulking.

6. Establish a connection between the plenum and the RCS to generate a slight negative pressure in the plenum so that radon released is exhausted through the carbon beds.

For a description of potential recovery operations related to the TTA tank rupture or leak scenario, refer to Section 9 of this Contingency Plan.

7.1.3 Fire

In the event of a fire or explosion, AWR Project personnel are to immediately evacuate the AWR Project site and meet at Rally Point #4 for accountability. No personnel are to fight a fire beyond the stage where it can be put out with a portable fire extinguisher.

For additional clarification, the following steps should be taken in case of a fire:

- Pull lever on the nearest FEMP Fire Alarm Box. If an alarm box is not nearby, dial 911 on a telephone to directly connect to the FEMP Communications Center (cellular phone, dial 648-6511), or use a portable radio by switching to Channel 7 and calling CONTROL. **WARNING: USING THE WRONG TYPE OF FIRE EXTINGUISHER CAN BE HAZARDOUS. DO NOT USE WATER TO EXTINGUISH ELECTRICAL, LIQUID, OR METAL FIRES.**

- If trained to use fire-fighting equipment (and can do so without endangering self), then combat the fire cautiously until ERT arrives. **(NOTE: Use METL-X for burning metal fires. Use CO_2, ABC, or dry chemical for electrical or flammable liquid fires. Use Class "A" (water) extinguisher or ABC fire extinguisher for trash, wood, and paper fires.)**

3157

- If possible and safe, shut off gas, electrical power, and operating equipment. Remove combustible or other hazardous material to secure location.

- If it becomes evident that the fire cannot be controlled by local action, then immediately notify personnel to evacuate the facility/area by contacting the FEMP Communication Center by telephone or portable radio. **WARNING: DO NOT LOCK FIRE OR EXIT DOORS.**

- Close Fire and Exit doors after facility has been evacuated.

- After evacuation, report to Rally Point #4 (see Appendix C to this Contingency Plan). **(NOTE: Instruct persons in transit to avoid the facility and surrounding area.)**

7.1.4 Onsite Vehicle Accidents

Restricted roadways and enforced low speed limits reduce the hazard potential of a vehicle accident onsite. If a spill or leak of hazardous/radiological material results from such an accident or during vehicle refueling operations, then the Foster Wheeler EC will perform the following steps when responding to a spill or leak that may potentially be an environmental release:

- Determine the nature and major component of the spill or leak,

- Make sure unnecessary persons are removed from the spill area,

- Notify the Fluor Fernald AEDO/EDO,

- Don proper PPE,

- Remove ignition sources if a flammable liquid, gas, or vapor is involved,

- Try to stop the leak with appropriate spill control materials that are kept on hand for temporary repairs, if possible,

- Remove surrounding materials that could react with the materials in the spill, and.

- Assist the Fluor Fernald ERT as requested.

7.1.5 Bomb Threats/Suspicious Devices

Personnel are to respond conservatively to bomb threats and the discovery of suspicious devices. For the purpose of this Contingency Plan, bomb threats and discovery of suspicious devices also include those related to biological/chemical threats and devices. Actions to respond to such an event are addressed in FEMP Site Procedure EM-0023, *Bomb Threat Procedure* (Fluor Fernald 1997a) and Site Procedure EM-0020, *Building Emergency Procedure* (Fluor Fernald 1998b).

Alert the Fluor Fernald AEDO/EDO immediately. Complete the bomb threat checklist, or equivalent, as provided in Appendix D to this Contingency Plan. An equivalent form is contained in the FEMP site phonebook. **NOTE: Anyone who receives a threat or finds a suspicious object in his/her area shall immediately notify FEMP Security by calling (or have someone else call) the FEMP Communications Center (648-6511 or 911).**

7.2 Protection of Offsite Personnel

Protective action recommendations are issued by FEMP when an event at the FEMP has or will have a potential offsite impact (i.e., General Emergency). Protective actions can either include sheltering, evacuation, or other protective actions for the 2-mile Immediate Notification Zone (INZ). The INZ was established with the concurrence of state and local officials and follows geographic boundaries. Protective actions for offsite personnel are implemented in accordance with FEMP Site Procedure, EM-0004, *Protective Actions*.

7.3 Protective Action Guides (PAGs)

DOE Order 151.1 specifies that the PAGs published by the U.S. Environmental Protection Agency (EPA) are to be used for comparison with exposures resulting from radiological releases to determine the appropriate emergency class. FEMP site-specific PAGs, and the related criteria for radiological releases, are implemented in accordance with FEMP Site Procedure, EM-0004, *Protective Actions*, and are summarized in Exhibit 7-1.

Exhibit 7-1. EPA PAGs for the Early Phase of Emergency

Protective Action	PAG (Projected Dose)	Comments
Evacuation (or Sheltering [a])	1-5 rem [b]	Evacuation (or for some situations sheltering) should normally be initiated at 1 rem.

[a] Sheltering may be the preferred protective action when it will provide protection equal to or greater than evacuation, based on consideration of factors such as source term characteristics and temporal or other site-specific conditions.
[b] The sum of the effective dose equivalent resulting from the exposure to external sources and the committed effective dose equivalent incurred from all significant inhalation pathways during the early phase. Committed dose equivalents to the thyroid and to the skin may be five and fifty times larger, respectively.

7.4 Emergency Response Planning Guides (ERPGs)

DOE Order 151.1 specifies that ERPGs developed and approved by the American Industrial Hygiene Association (AIHA) are to be used for comparison with exposures resulting from non-radiological releases to determine the appropriate emergency class. The AIHA ERPGs should be used as the basis for protective action criteria for non-radiological releases.

If no suitable exposure criterion can be found for a substance of interest, then the FEMP will use EPA level of concern (LOC) values in place of ERPGs as the basic protective action criteria for non-radiological releases. It is not anticipated that the AWR Project will use the chemicals listed in FEMP Site Procedure EM-0004 of type or quantity to invoke the use of ERPGs.

3157

7.5 Records

Records associated with the AWR Project are maintained in accordance with the *Records Management Plan*, Document No. 624-P621-04, and related AWR Project procedures. FEMP records, including the log of emergency events, are managed by Fluor Fernald. All events are recorded in a daily log by Fluor Fernald, and the appropriate notifications and reports are made for only those events categorized as Off-Normal Occurrences or higher.

7.6 Personnel Accountability/Evacuation

Evacuation is the preferred protective action for most types of emergencies. Most events are localized and distance ensures safety. Rally Points are provided near the AWR Project work area to provide for the assembling of, control of, and communications with evacuated personnel (see Appendix C to this Contingency Plan). Regardless of whether sheltering or evacuation is ordered, it is essential that personnel in evacuated facilities be accounted for to determine if anyone is missing and still in danger.

After evacuation, AWR Project personnel will assemble at the Rally Point and be counted. The Foster Wheeler EC will designate an employee to log the head count and report unaccounted personnel back to the Foster Wheeler EC, who in turn, will attempt to reconcile the head count report, as needed. Attempts will be made to locate unaccounted personnel as long as it does not endanger the lives of others by reentry into the emergency area.

7.7 Reentry

Each accident is a unique event and the requirement for reentry activities will depend on the nature of the specific accident. Therefore, the response structure for conducting reentry activities must be flexible and capable of responding to a wide range of conditions. Reentry activities will often involve high risk, time-urgent actions. Fluor Fernald Emergency Response management may be called upon to make a rapid risk versus benefit type decision and then establish priorities for selected activities. Foster Wheeler will assist Fluor Fernald in this area as requested.

The Fluor Fernald AEDO, as the FEMP's Incident Commander for emergency response, will be the identified person within the FEMP Emergency Response Organization with the authority and responsibility to authorize reentry activities. Reentry of AWR Project personnel to the AWR Project area will be allowed only after the Foster Wheeler EC (or designee) makes this announcement and gives appropriate reentry instructions.

7.8 Emergency Planning Zone (EPZ)

The EPZ is the geographic area surrounding the FEMP for which planning and preparedness efforts are carried out to ensure that prompt and effective protective actions can be taken to reduce adverse effects of an emergency at the FEMP. Protective actions for the five-mile EPZ are implemented in accordance with FEMP Site Procedure EM-0004, *Protective Actions.*

000244

7.9 Communication

Other than the initial notification to onsite AWR Project personnel and the Fluor Fernald AEDO, all other emergency communications are the responsibility of Fluor Fernald. These communications include those made to offsite response agencies, as needed, and are performed by DOE and Fluor Fernald in accordance with the *FEMP Emergency Plan.*

7.10 Termination of Protective Actions

The decision related to the termination of protective actions rests with the Fluor Fernald Deputy Emergency Director (DED), in consultation with other FEMP EOC staff, as is the case with terminating the emergency event itself (see Section 9.1 of this Contingency Plan).

7.11 Shutdown of Operations

In the event of an emergency, safe shutdown of AWR Project operations will be conducted in accordance with applicable operations procedures for each facility/operation. Safe shutdown is also addressed in the training associated with AWR Project personnel involved in operations and maintenance at the facilities. In addition, AWR Project operations are alarmed remotely to the VitPP Control Room and operations can be safely and remotely shutdown from the AWR Project Control Trailer, as necessary.

000245

8.0 EMERGENCY MEDICAL SUPPORT

3157

"Medical support shall be planned in accordance with DOE Orders for workers contaminated by hazardous material..."

8.1 AWR Project Site

Procedures and rules designed to prevent employee injury are provided in the AWR Project Specific HASP. During the site safety briefing of each employee, AWR Project personnel will be informed of the emergency medical procedures for the AWR Project.

Should an injury occur at the AWR Project site, no matter how slight, it will be reported to the Foster Wheeler Site S&H Representative immediately. Unless they are in immediate danger, severely injured persons will not be moved until Emergency Medical Technicians (EMTs) can attend to them. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions that can be obtained from doctors or EMTs before the Fluor Fernald ERT arrives at the site or before the injured person can be transported to the hospital will be followed closely.

As a standard safety precaution, Foster Wheeler will provide at least two personnel with current First Aid and Cardiopulmonary Resuscitation (CPR) certification on each active work shift for the AWR Project. When personnel are transported to the hospital, the Site S&H Representative will provide a copy of the employee's Medical Data Sheet to the paramedics and treating physician. Only in non-emergency situations will an injured person be transported to the hospital by means other than an ambulance.

8.2 FEMP Site

The FEMP site Medical Section is located in the Safety & Health Building (Building 53) and uses a variety of analytical, diagnostic, testing, and treatment resources to support the health and medical needs of the site population. The FEMP also maintains immediate, onsite first aid and emergency medical treatment capability through the Medical and the Fire Protection and Emergency Response groups. Triage can also be established onsite in the case of mass casualty events. The FEMP Medical Division is responsible for the establishment and management of a treatment area when the need for triage is determined by the FEMP Incident Commander (Fluor Fernald 1999a).

During normal working hours (Monday – Friday, 7:00 AM to 3:30 PM, excluding holidays), the Medical Staff includes, at a minimum, two doctors, five nurses, and several EMTs. The FEMP Fire Protection and Emergency Response group provides coverage 24 hours, 7 days a week for the site ambulance that is staffed by a minimum of two EMTs, with support of the entire medical staff. The FEMP Fire Protection and Emergency Response group operates two fully equipped ambulances designed to federal standards.

Decontamination and treatment facilities for injured and/or contaminated personnel are available at all times. These facilities are located at the rear of FEMP Building 53 near the Medical Treatment Area. The FEMP maintains many safety showers, eye wash stations, and radiological control points throughout the site and project areas where decontamination may be provided prior to, or in conjunction with, emergency medical treatment.

000246

8.3 Offsite

In addition to onsite medical support, emergency transportation of injured personnel to offsite medical facilities can be accomplished by either FEMP ambulance, local (mutual aid) ambulance, or AirCare helicopter. Mutual agreements have established criteria and response protocols for interaction with offsite agencies for medical emergencies at or around the FEMP. These agreements are reviewed on a regular basis to ensure that the needs of the FEMP, as well as those of the surrounding community, are being adequately met.

000247

9.0 EMERGENCY TERMINATION AND RECOVERY

3157

"Detail notifications associated with termination of an operational emergency and the criteria for resumption of normal operations..."

9.1 Emergency Termination

The primary responsibility for event termination rests with the Fluor Fernald DED upon receiving concurrence from DOE, Butler and Hamilton Counties, and the State of Ohio. The DOE Headquarters EOC may review and approve classification changes to event termination and the recovery plan for all emergencies. Fluor Fernald uses the criteria provided in FEMP Site Procedure EM-0003, *Reentry and Recovery* (Fluor Fernald 1998a), in determining whether or not an emergency can be terminated.

9.2 Recovery

The objective of recovery is to return the facility/area to normal operations. The manner to accomplish recovery and the level of effort required will be determined by the nature and magnitude of the event. Prior to the termination of any emergency, the Fluor Fernald DED will establish the recovery organization and determine the resources needed to begin recovery operations. Recovery operations can be categorized into three general areas of recovery:

- Accident Assessment and Investigation,
- Planning and Scheduling, and
- Facility/Site/Environmental Restoration.

Fluor Fernald will conduct recovery operations in accordance with FEMP Site Procedure EM-0003 (Fluor Fernald 1998a). Foster Wheeler will assist Fluor Fernald, as requested, in emergency termination and recovery operations. In general, subsequent to an emergency event in which operations/facilities may have been impacted, the following warnings are to be observed prior to restart:

- If hazardous materials were released, then do not enter building or area until FEMP Industrial Hygiene has conducted monitoring.
- If propane or natural gas were involved when equipment was damaged, then do not start equipment until FEMP Fire and Safety has checked for explosive gas.
- If radioactive materials were released, then do not enter the building or area until FEMP Radiological Safety has conducted a check for radioactive contamination.

9.2.1 Silo Dome Collapse

Fluor Fernald has developed an Emergency Recovery Action Plan describing both immediate and subsequent actions that are to be taken in the unlikely event of a catastrophic failure of

Silos 1, 2, or 3 at the FEMP (Fluor Fernald 1998c). The immediate actions were previously described in Section 7 of this Contingency Plan, and are implemented at the FEMP in accordance with FEMP Site Procedure EM-0030, *Silos Area Emergency Procedure*, and the FEMP ERT Fire Preplan. Four types of recovery actions, depending on the size and mode of failure, are identified in the *OU 4 Silos: An Analysis of Emergency Recovery Actions – Phase II* report (Fluor Fernald 1998c), and are summarized below:

1. Cover leak from small crack in silo dome with encapsulant material;
2. Cover small hole or large crack in silo dome with encapsulant material;
3. Cover large hole or partial failure of silo with synthetic membrane and spray encapsulant material; and
4. Cover silo with synthetic membrane and spray with encapsulant material.

A white metal box containing tarps (i.e., synthetic membrane) and anchors for silo containment that is marked "K-65 Emergency Equipment" is located adjacent to the emergency diesel generator, northeast of the K-65 Silos. In the event of a partial dome collapse, the Fluor Fernald AEDO will evaluate the placing of tarps over the collapsed area. Foster Wheeler and Fluor Fernald will work together to resolve any potential interferences caused from AWR Project activities, equipment, or facilities with the four types of recovery actions identified above.

9.2.2 TTA Tank Rupture or Leak

In the unlikely event that a rupture or leak occurs in a TTA Transfer Storage Tank, the following is provided as a potential scenario for tank repair and recovery. These actions will only be taken after the appropriate notifications and upon concurrence from Fluor Fernald.

1. After identifying which tank is leaking, operators will lower a sump pump from the TTA equipment deck into the containment sump. The sump pump is sized to remove the maximum volume of free liquid contained in any tank within 24 hours. The system is designed to allow the sump contents to be pumped to any of the four tanks.
2. A leak could be postulated in the tank bottom, or at any location in the shell from top to bottom. Depending upon where the tank may be leaking, and since the residues are stored at approximately 39-weight % water, it is not possible to conclude that all the free liquid above the leak will drain to the sump in 24 hours. If a tank is leaking from the bottom, then repair of the tank will not be possible and removal of the contents cannot be accomplished in 24 hours. However, since potential leaks are contained within the containment structure, no immediate danger exists to human health or the environment.
3. As a worst case scenario, Foster Wheeler assumes that storage tank TTA_{1A} is full and starts leaking from its bottom. The 633,159 gallons of residues and water, which includes the two feet of shield water stored in the tank, can be removed and stored in the unused portions and freeboard area of the remaining three storage tanks. The available volume for the remaining tanks is 687,158 gallons. But to make this space available, the 150,000 gallons of shield water in the three remaining tanks would have to be removed.

3157

4. The residues would be removed to a level below where the tank is leaking by implementation of the TWRS. If an identified leak is in the tank shell, then an investigation will determine if the leak is repairable by welding. The following steps are required to implement a weld repair:

   a) The residue level in the tank has been lowered below the affected area.

   b) Visual inspection (by CCTV) from inside and outside the tank is made to determine the extent of damage.

   c) If deemed repairable, then an opening is cut in the TTA equipment deck above the affected area.

   d) Radiological surveys are performed to assess variations of repair scenarios.

   e) A decision is required as to whether the tank containment area must be connected to the RCS. If it is necessary to ventilate the containment area, then additional openings must be cut in the TTA equipment deck, and ducting provided to the RCS.

   f) Repair is performed by grinding the affected area and welding directly, or a plate is "scabbed" over the area and seal welded. In any case, the weld repair must be done in accordance with American Petroleum Institute (API) 650 requirements and certified by a professional engineer.

   g) Following repair, a tightness test is performed by adding clean water to a level above the repair to check for leaks.

   h) If repaired successfully, then the tank will be returned to service. If not, then the tank will be abandoned in place.

000250

10.0 PUBLIC INFORMATION

"Public affairs policy and planning requirements apply for all emergencies..."

The dissemination of public information that relates to emergencies at the FEMP site is the responsibility of Fluor Fernald and DOE. This information dissemination will be conducted in accordance with of the *FEMP Emergency Plan.* The Fluor Fernald Director of Public Affairs has the overall responsibility for the emergency public information program and serves as the designated spokesperson at the FEMP during emergencies.

News and information about an emergency is provided to the media through either the Fluor Fernald Public Affairs Division offices, or the Joint Information Center (JIC) if it is activated for a major event. The role of Foster Wheeler is to solely provide technical support to Fluor Fernald, as requested, in accordance with the interfaces described in Section 3 of this Contingency Plan.

000251

3157

11.0 EMERGENCY FACILITIES AND EQUIPMENT

"Facilities and equipment adequate to support emergency response shall be available and maintained..."

11.1 FEMP Emergency Facilities

Dedicated facilities give emergency responders necessary resources for controlling an incident and emergency equipment is essential for effective event mitigation and control. These facilities and equipment for the FEMP site are fully described in the *FEMP Emergency Plan*. The FEMP emergency facilities include, but are not limited to, the following:

- EOC (located in the FEMP Administration Building),
- JIC (located offsite in the Delta Building),
- FEMP Communications Center (staffed onsite 24-hours a day),
- Mobile EOC (i.e., FEMP's Alternate EOC),
- Decontamination facilities (at the rear of Building 53), and
- Medical facilities (located in the Safety & Health Building, i.e., Building 53).

11.2 FEMP Emergency Equipment

FEMP maintains the equipment listed in FEMP Site Procedure EM-0001, *Equipment Inventory for Emergency Preparedness*. Some of the emergency equipment at FEMP includes:

- Communication and warning systems such as telephones, onsite and offsite Emergency Management System (EMS), FM radios, high frequency/single-side band radios, and pagers,
- Fire/rescue equipment such as fire pumpers, rescue vehicle, hazardous materials (HAZMAT) unit and trailer, water tanker, mobile air supply trailer, and ambulance/life squads,
- Monitoring equipment for both chemical and radiological contaminants,
- Emergency power system for lighting, communications, and certain plant operations,
- Decontamination equipment for both personnel and equipment, and
- Miscellaneous equipment such as respirators, PPE, shower/eyewash stations, emergency lighting, man-lift baskets and cranes, etc.

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11.3 AWR Project Area Emergency Equipment and Facilities

Foster Wheeler will be supported in emergency response situations by Fluor Fernald through the use of the FEMP emergency facilities and equipment described above. In conjunction with the FEMP emergency capabilities, emergency equipment will be available at various locations in and around the AWR Project site, consisting of emergency eye wash stations and drench showers (see Appendix C to this Contingency Plan). Fire extinguishers, rated at least 10 pounds ABC, will be located on heavy equipment, in trailers, and near hot work areas. Other AWR Project site-specific emergency equipment includes:

- Respirators and other PPE,
- Material Safety Data Sheets (MSDSs),
- Absorbent material,
- Signal flags and traffic vests, and
- Laminated postings of emergency telephone numbers, equipment locations, and evacuation routes and staging areas.

As identified in the *Silos Area Emergency Procedure*, FEMP Site Procedure EM-0030, emergency equipment in the Silos Area includes the following:

- Fire and evacuation alarm system controls,
- Fire extinguishers and safety showers/eye bubblers,
- Portable radios,
- Continuous environmental radon monitors surrounding the Silo 1 and 2 EZ, and
- A white metal box containing tarps and anchors for silo containment that is marked "K-65 Emergency Equipment" is located adjacent to the emergency diesel generator, northeast of the K-65 Silos, and is maintained by Fluor Fernald.

In addition, local evacuation alarms are provided in the VitPP Control Room for the AWR Project. These alarms will annunciate if the RCS stack alarm is activated. Additional types of emergency communications are available at the AWR Project site such as telephones (e.g., office, cellular, and pagers) and radios, as described in Section 5.4 of this Contingency Plan. Emergency communications for the AWR Project must be consistent with and tie into the FEMP site emergency communications system.

000253

3157

12.0 PROGRAM ADMINISTRATION

"Each facility subject to this Order shall designate an individual to administer emergency management..."

12.1 Emergency Management Program Administrator

The AWR Project ESQ Manager is responsible for developing and maintaining this Contingency Plan for the AWR Project. The AWR Project ESQ Manager will review this Contingency Plan biannually for appropriateness and to check its consistency with the FEMP Emergency Plan. These self-assessments will be conducted to ensure that this Contingency Plan is in effect and that all pre-emergency requirements are met.

The AWR Project ESQ Manager acts as a liaison to Fluor Fernald regarding regulatory issues and notifies the OSHA of reportable accidents (see Section 5.1 of this Contingency Plan). The Foster Wheeler Senior Supervisor (during Construction phase) or the Shift Supervisor on duty (during Operations/Maintenance/Systems Closure phase) serves as the Foster Wheeler EC for the AWR Project. This person reports directly to the Foster Wheeler PM, and is responsible for the effective implementation of this Contingency Plan at the AWR Project site.

12.2 Drills, Exercises, and Training

Drills and exercises help to ensure effective emergency response by bringing together trained personnel under simulated emergency conditions for practice and evaluation. AWR Project personnel will participate in FEMP drills and exercises as determined by the Fluor Fernald Emergency Preparedness Section. The frequency of a Building Specific Emergency Drill, which can be correlated to the AWR Project area requirements, is once annually. This drill would test emergency program elements such as protective actions, facilities, and equipment (Fluor Fernald 1999a). Foster Wheeler will also support the FEMP Lessons Learned program for emergency preparedness as requested by Fluor Fernald.

Prior to performing work onsite, AWR Project personnel will each receive FEMP General Employee Training (GET) that provides an overview of the emergency management requirements at FEMP. The FEMP Centralized Training Section conducts this training. In addition, AWR Project personnel will be trained on the AWR *Project Specific HASP*, which includes the specific actions to be taken at the site in the event of an emergency. Topics relating to emergency response are discussed in the daily safety briefings at the AWR Project site. The Foster Wheeler EC is responsible for providing training and briefings to the AWR Project personnel, such as:

- Conducts periodic training of assigned employees in the location and use of fire and evacuation alarm system controls and emergency procedures,
- Conducts periodic training of new and newly relocated employees in the location and basic use of fire extinguishers and safety shower/eye bubblers in their immediate work area, and
- Conducts periodic training of employees with regard to immediate actions to be taken for credible types of emergencies that could occur at the site.

000254

AWR Project personnel will also be instructed on proper emergency response procedures and locations of emergency telephone numbers during their initial site safety meeting. Foster Wheeler will abide by the Employee Bill of Rights and will inform AWR Project personnel of these rights in accordance with Parts 7 and 8 of the AWR Contract. Foster Wheeler will honor the right of any employee to refuse work, which the employee reasonably believes to be hazardous.

Employees have the right to STOP WORK for which they reasonably believe controls are inadequate for radiological and other hazards. Reprisals will not be taken against employees for exercising their rights in a responsible manner, and responsibly stopped work will not resume until proper controls are established with concurrence by Fluor Fernald.

Each AWR Project person is also required to:

- Become familiar with the provisions of this Contingency Plan for reporting emergencies,
- Become familiar with the location and use of emergency items,
- Participate in emergency drills and training as required, and
- Immediately notify the supervisor or Foster Wheeler EC of emergency or non-routine events.

12.3 Document Control

Documentation and record keeping of training provided to AWR Project personnel are to be kept current. Document control and records management will be conducted in accordance with AWR Project plans and procedures. Training information will be documented and tracked for each trained employee.

000255

L - 3157

13.0 REFERENCES

(AHIA 1992) American Industrial Hygiene Association, *Emergency Response Planning Guides*, 1992.

(DOE 1996) U.S. Department of Energy Order 151.1, *Comprehensive Emergency Management*, Change 2, August 21, 1996.

(Fluor Fernald 1997) FEMP Site Procedure EM-0004, *Protective Actions*, Rev. 1, November 27, 1997.

(Fluor Fernald 1997a) FEMP Site Procedure EM-0023, *Bomb Threat Procedure*, Rev. 2, November 21, 1997.

(Fluor Fernald 1997b) *Operable Unit 4 (OU4) Silos: An Analysis of Emergency Recovery Actions – Phase I*, 40000-RP-0018, Rev. 1, June 11, 1997.

(Fluor Fernald 1998) *Hazards Analysis Report for Operable Unit 4 (OU4) Silos*, Rev. 0, May 26, 1998.

(Fluor Fernald 1998a) FEMP Site Procedure EM-0003, *Reentry and Recovery*, Rev. 3, April 24, 1998.

(Fluor Fernald 1998b) FEMP Site Procedure EM-0020, *Building Emergency Procedure*, Rev. 5 (PCN1), February 17, 1998.

Fluor Fernald 1998c) *Operable Unit 4 (OU4) Silos: An Analysis of Emergency Recovery Actions – Phase II*, 40000-RP-0029, Rev. 0, April 30, 1998.

(Fluor Fernald 1999) *1998 Integrated Site Environmental Report*, Fluor Daniel Fernald, June 1999.

(Fluor Fernald 1999a) *FEMP Emergency Plan*, Rev. 4, May 25, 1999.

(Fluor Fernald 1999b) FEMP Site Procedure EM-0030, *Silos Area Emergency Procedure*, Rev. 3, March 24, 1999.

(Fluor Fernald 1999c) FEMP Site Requirements Manual RM-0021, *Safety Performance Requirements Manual*, Rev. 22, November 12, 1999.

000256

3157

APPENDICES

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APPENDIX A

FEMP Emergency Action Level (EAL) Guides Adapted from the *FEMP Emergency Plan* for the AWR Project

000258

3157

RADIOLOGICAL EVENTS			
Radiological Events	**Alert**	**Site Area**	**General**
Criteria	Loss of accountable special nuclear material. Unplanned release of radioactive material projected to result in an exposure at the facility boundary ≥ 100 mrem TEDE but < 1 rem TEDE.	Unplanned release of radioactive material projected to result in an exposure at the facility boundary ≥ 1 rem TEDE.	Unplanned release of radioactive material projected to result in an exposure at the site boundary ≥ 1 rem TEDE or ≥ 5 rem thyroid.
Onsite Protective Actions	• Shelter in place, if possible, evacuate immediate danger area. • Rally point accountability. • Employee announcement. • Bioassay at termination.		
Offsite Protective Actions	• Update counties and state regularly. • Monitoring onsite and/or offsite.		• Activate offsite warning system. • Issue Protective Actions Recommendations. • Implement applicable Resource Conservation and Recovery Act (RCRA) plan.
Event Mitigation Actions	• Contain event, • Isolate area, • Terminate release, • Monitor onsite/offsite, and • Clean up.		
Response Groups	• Emergency Duty Officers, • Emergency Operations Center, • Joint Information Center, • Monitoring teams, • Security (Recall), • Medical (Recall), • Emergency Response Team (Recall), and • Mutual Aid (as needed).		

000259

HAZARDOUS MATERIAL EVENTS			
Hazardous Material Events	**Alert**	**Site Area**	**General**
Criteria	Unplanned release of hazardous substance resulting in a projected airborne concentration at the facility boundary ≥ ERPG-1 and < ERPG- 2 (AIHA 1992). If ERPG values are not available, projected airborne concentration at the facility boundary ≥ Permissible Exposure Limit (PEL)-Short-Term Exposure Limit (STEL) and < EPA LOC values.	Unplanned release of a hazardous substance resulting in a projected airborne concentration between the facility boundary and the site boundary is ≥ ERPG-2. If ERPG values are not available, ≥ EPA LOC values.	Unplanned release of a hazardous substance resulting in a projected airborne concentration at the site boundary is ≥ ERPG-2. If ERPG values are not available, ≥ EPA LOC values.
Onsite Protective Actions	• Shelter in place, if possible, evacuate immediate danger area. • Rally point accountability. • Employee announcement. • Bioassay at termination.		
Offsite Protective Actions	• Update counties and state regularly. • Monitoring onsite and/or offsite.		• Activate offsite warning system. • Issue Protective Action Recommendations.
Event Mitigation Actions	• Contain event, • Isolate area, • Terminate release, • Monitor onsite/offsite, • Implement applicable RCRA plan, and • Clean up.		
Response Groups	• Emergency Duty Officers, • Emergency Operations Center, • Joint Information Center, • Monitoring teams, • Security (Recall), • Medical (Recall), • Emergency Response Team (Recall), and • Mutual Aid (as needed).		

000260

3157

HEALTH AND SAFETY EVENTS			
Health & Safety Events	**Alert**	**Site Area**	**General**
Criteria	The following events or conditions represent, cause, or have the potential to cause serious health and safety impacts to workers or members of the public. • Radioactive or other hazardous material contamination that is causing or may reasonably be expected to cause uncontrolled personnel exposures exceeding protective action criteria. • An offsite hazardous material event not associated with DOE operation that is observed to have or is predicted to have an impact on a DOE site such that protective actions are required for onsite DOE workers. • An occurrence that causes or can reasonably be expected to cause significant structural damage to DOE facilities, with confirmed or suspected personnel injury or death or substantial degradation of health and safety. • Any facility evacuation in response to an actual occurrence that requires time-urgent response by specialist personnel, such as hazardous material responders or mutual aid groups not normally assigned to the affected facility. • An unplanned nuclear criticality resulting in actual or potential facility damage and /or release of radioactive material to the environment. • Any onsite transportation-related mass casualty event.		
Onsite-Protective Actions	• Shelter in place if possible, evacuate immediate danger area, • Rally point accountability, • Employee announcement, and • Bioassay at termination.		
Offsite-Protective Actions	• Update counties and state regularly. • Monitoring onsite and/or offsite.		• Activate offsite warning system. • Issue Protective Action Recommendations. • Implement applicable RCRA plan.
Event Mitigation Actions	• Contain event, • Isolate area, • Terminate release, • Monitor onsite/offsite, and • Clean up.		
Response Groups	• Emergency Duty Officers, • Emergency Operations Center, • Joint Information Center, • Monitoring teams, • Security (Recall), • Medical (Recall), • Emergency Response Team (Recall), • Mutual Aid (as needed).		

000261

ENVIRONMENTAL EVENTS			
Environmental Events	**Alert**	**Site Area**	**General**
Criteria	The following events or conditions represent, cause, or have the potential to cause serious detrimental effects on the environment. • Any actual or potential release of dispensable, material or regulated pollutant to the environment, in a quantity greater than five times the Reportable Quantity (RQ) specified for such material in Title 40 of the Code of Federal Regulations (CFR) Part 302, that could on a case-specific basis result in significant offsite consequences such as major wildlife kills, wetland degradation, aquifer contamination, or the need to secure downstream water supply intakes. • Any release of greater than 1,000 gallons (24 barrels) of oil to inland waters; greater than 10,000 gallons (238 barrels) of oil to coastal waters; or a quantity of oil that could result in significant offsite consequences (e.g., need to relocate people, major wildlife kills, wetland degradation, aquifer contamination, need to secure downstream water supply intakes, etc.). [Oil as defined by the Clean Water Act (33 U.S.C. 1321) means any kind of oil and includes petroleum.] • For the AWR Project, the most restrictive substance to be considered for a release is "lead and lead compounds" in the K-65 material. A "5 x RQ" value for this substance is approximately 25 pounds of undiluted K-65 material.		
Onsite- Protective Actions	• Shelter in place, if possible, evacuate immediate danger area. • Rally point accountability, • Employee announcement, and • Bioassay at termination.		
Offsite-Protective Actions	• Update counties and state regularly. • Monitoring onsite and/or offsite.		• Activate offsite warning system. • Issue Protective Action Recommendations. • Implement applicable RCRA plan.
Event Mitigation Actions	• Contain event, • Isolate area, • Terminate release, • Monitor onsite/offsite, and • Clean up.		
Response Groups	• Emergency Duty Officers, • Emergency Operations Center, • Joint Information Center, • Monitoring teams, • Security (Recall), • Medical (Recall), • Emergency Response Team (Recall), and • Mutual Aid (as needed).		

000262

3157

APPENDIX B

AWR Project
Foster Wheeler Accident/Incident Report Forms

000263

3157

CORPORATE ESQ REPORT #

FOSTER WHEELER ENVIRONMENTAL CORPORATION

AWR PROJECT
INCIDENT/NEAR MISS REPORT AND INVESTIGATION

TYPE OF INCIDENT - CHECK ALL THAT APPLY

☐ INJURY/ILLNESS ☐ VEHICLE DAMAGE ☐ PROPERTY DAMAGE ☐ FIRE
☐ SPILL/RELEASE ☐ PERMIT EXCEEDENCE ☐ HIGH LOSS POTENTIAL ☐ OTHER
☐ (NEAR MISS)

GENERAL INFORMATION

AWR PROJECT REPORT #: DATE OF REPORT:

DATE OF INCIDENT: MILITARY TIME: ____ DAY OF WEEK: ____

FW SUPERVISOR ON DUTY: AT SCENE OF INCIDENT: ☐ YES ☐ NO

LOCATION OF INCIDENT:

WEATHER CONDITIONS: ADEQUATE LIGHTING AT SCENE: ☐ YES ☐ NO ☐ N/A

DESCRIBE WHAT HAPPENED (STEP BY STEP - use additional pages if necessary)

AFFECTED EMPLOYEE INFORMATION

NAME: FWENC EMPLOYEE: ☐ YES ☐ NO

EMPLOYEE #: OFFICE PHONE #:

JOB CLASSIFICATION: YEARS IN JOB CLASSIFICATION:

HOURS WORKED ON SHIFT PRIOR TO INCIDENT: YEARS WITH FWENC: AGE:

DID INCIDENT RELATE TO ROUTINE TASK FOR JOB CLASSIFICATION: ☐ YES ☐ NO

INJURY/ILLNESS INFORMATION

NATURE OF INJURY OR ILLNESS:

OBJECT/EQUIPMENT/SUBSTANCE CAUSING HARM:

FIRST AID PROVIDED: ☐ YES ☐ NO

IF YES, WHERE WAS IT GIVEN: ☐ ON SITE ☐ OFF SITE

IF YES, WHO PROVIDED FIRST AID:

WILL THE INJURY/ILLNESS RESULT IN: ☐ RESTRICTED DUTY ☐ LOST TIME ☐ UNKNOWN

MEDICAL TREATMENT INFORMATION

WAS MEDICAL TREATMENT PROVIDED?: ☐ YES ☐ NO

IF YES, WAS MEDICAL TREATMENT PROVIDED: ☐ ONSITE ☐ DR.'S OFFICE ☐ HOSPITAL

NAME OF PERSON(S) PROVIDING TREATMENT:

ADDRESS WHERE TREATMENT WAS PROVIDED:

TYPE OF TREATMENT:

AWR PROJECT
INCIDENT/NEAR MISS REPORT AND INVESTIGATION

VEHICLE AND PROPERTY DAMAGE INFORMATION

VEHICLE/PROPERTY DAMAGED:

DESCRIPTION OF DAMAGE:

SPILL AND AIR EMISSIONS INFORMATION

SUBSTANCE SPILLED OR RELEASED: FROM WHERE: TO WHERE:

ESTIMATED QUANTITY/DURATION:

CERCLA HAZARDOUS SUBSTANCE? YES ☐ NO ☐ RQ EXCEEDED? YES ☐ NO ☐ SPECIFY: _____

REPORTABLE TO AGENCY? YES ☐ NO ☐ SPECIFY: _____

WRITTEN REPORT? YES ☐ NO ☐ TIME FRAME: _____

RESPONSE ACTION TAKEN:

PERMIT EXCEEDENCE

TYPE OF PERMIT: PERMIT #:

DATE OF EXCEEDENCE: DATE FIRST KNOWLEDGE OF EXCEEDENCE:

PERMITTED LEVEL OR CRITERIA (e.g., Water quality):

EXCEEDENCE LEVEL OR CRITERIA: EXCEEDENCE DURATION:

REPORTABLE TO AGENCY? YES ☐ NO ☐ SPECIFY: _____

WRITTEN REPORT? YES ☐ NO ☐ TIME FRAME: _____

RESPONSE ACTION TAKEN:

NOTIFICATIONS

NAME(S) OF FWENC PERSONNEL NOTIFIED: DATE/TIME:

CLIENT NOTIFIED: DATE/TIME:

AGENCY NOTIFIED: DATE/TIME: ☐ NOT REQUIRED

CONTACT NAME:

PERSONS PREPARING REPORT

EMPLOYEE'S NAME: (PRINT) SIGN:

EMPLOYEE'S NAME: (PRINT) SIGN:

SUPERVISOR'S NAME: (PRINT) SIGN:

NOTE: Supervisor to forward a copy of Incident Report to immediate supervisor, PESM, ESS or ESC, and other personnel deemed appropriate, as soon as possible but no later then 24 hours.

INVESTIGATIVE REPORT

REPORT #: _____

DATE OF INCIDENT: _____ DATE OF INVESTIGATION REPORT: _____

INCIDENT COST: ESTIMATED: $_____ ACTUAL: $_____

OSHA RECORDABLE(S): ☐ YES ☐ NO # RESTRICTED DAYS_____

DAYS AWAY FROM WORK_____

CAUSE ANALYSIS

IMMEDIATE CAUSES – WHAT ACTIONS AND CONDITIONS CONTRIBUTED TO THIS EVENT? (USE NEXT PAGE)

BASIC CAUSES – WHAT SPECIFIC PERSONAL OR JOB FACTORS CONTRIBUTED TO THIS EVENT? (USE NEXT PAGE)

ACTION PLAN

REMEDIAL ACTIONS – WHAT HAS AND OR SHOULD BE DONE TO CONTROL EACH OF THE CAUSES LISTED? INCLUDE MANAGEMENT PROGRAMS (SEE ATTACHED LIST) FOR CONTROL OF INCIDENTS IF APPLICABLE.

ACTION	PERSON RESPONSIBLE	TARGET DATE	COMPLETION DATE

PERSONS PERFORMING INVESTIGATION

INVESTIGATOR'S NAME: (PRINT) SIGN: DATE:

INVESTIGATOR'S NAME: (PRINT) SIGN: DATE:

INVESTIGATOR'S NAME: (PRINT) SIGN: DATE:

MANAGEMENT REVIEW

PROJECT MANAGER: (PRINT) SIGN: DATE:

COMMENTS:

PESM or ESC: (PRINT) SIGN: DATE:

COMMENTS:

NOTE: Attach additional information as necessary. Supervisor to forward copy of Investigative Report to the PM, PESM, or ESC, as soon as possible but no later then 72 hours after the incident. A copy shall be sent to the Director, Health and Safety Programs within 24 hours of completion of the report.

EXAMPLES OF IMMEDIATE CAUSES	
SUBSTANDARD ACTIONS	SUBSTANDARD CONDITIONS
1. OPERATING EQUIPMENT WITHOUT AUTHORITY	1. GUARDS OR BARRIERS
2. FAILURE TO WARN	2. PROTECTIVE EQUIPMENT
3. FAILURE TO SECURE	3. TOOLS, EQUIPMENT, OR MATERIALS
4. OPERATING AT IMPROPER SPEED	4. CONGESTION
5. MAKING SAFETY DEVICES INOPERABLE	5. WARNING SYSTEM
6. REMOVING SAFETY DEVICES	6. FIRE AND EXPLOSION HAZARDS
7. USING DEFECTIVE EQUIPMENT	7. POOR HOUSEKEEPING
8. FAILURE TO USE PPE PROPERLY	8. NOISE EXPOSURE
9. IMPROPER LOADING	9. EXPOSURE TO HAZARDOUS MATERIALS
10. IMPROPER PLACEMENT	10. EXTREME TEMPERATURE EXPOSURE
11. IMPROPER LIFTING	11. ILLUMINATION
12. IMPROPER POSITION FOR TASK	12. VENTILATION
13. SERVICING EQUIPMENT IN OPERATION	13. VISIBILITY
14. UNDER INFLUENCE OF ALCOHOL/DRUGS	
15. HORSEPLAY	

EXAMPLES OF BASIC CAUSES	
PERSONAL FACTORS	JOB FACTORS
1. CAPABILITY	1. SUPERVISION
2. KNOWLEDGE	2. ENGINEERING
3. SKILL	3. PURCHASING
4. STRESS	4. MAINTENANCE
5. MOTIVATION	5. TOOLS/EQUIPMENT
	6. WORK STANDARDS
	7. WEAR AND TEAR
	8. ABUSE OR MISUSE

MANAGEMENT PROGRAMS FOR CONTROL OF INCIDENTS	
1. LEADERSHIP AND ADMINISTRATION	10. HEALTH CONTROL
2. MANAGEMENT TRAINING	11. PROGRAM AUDITS
3. PLANNED INSPECTIONS	12. ENGINEERING CONTROLS
4. TASK ANALYSIS AND PROCEDURES	13. PERSONAL COMMUNICATIONS
5. TASK OBSERVATION	14. GROUP MEETINGS
6. EMERGENCY PREPAREDNESS	15. GENERAL PROMOTION
7. ORGANIZATIONAL RULES	16. HIRING AND PLACEMENT
8. ACCIDENT/INCIDENT ANALYSIS	17. PURCHASING CONTROLS
9. PERSONAL PROTECTIVE EQUIPMENT	

NOTIFICATION REMINDER
Fatalities or hospitalization (admittance) of three or more individuals requires notification to OSHA within 8 hours. Contact the Director, Health and Safety Programs or Director, ESQ Programs to make the notification. If unavailable, the senior operations person on site should make the notification.

INCIDENT/NEAR MISS REPORT AND INVESTIGATION INSTRUCTIONS

General: The incident report must be completed within 24 hours. Do not delay the report if any information is unknown. It can be provided later by revising the Report.

Type of Incident: Check all that apply. A High Loss Potential (Near Miss) incident is one that does not result in loss, but under slightly different circumstances, could have resulted in an OSHA Recordable injury, spill, release, permit exceedence, fire, or vehicle/property damage in excess of $500. All High Loss Potential (Near Miss) incidents are to be investigated.

General Information

Project/Office: If the incident occurs on a delivery order contract, give the contract/program name, Delivery Order # and location. If the incident occurs on a Consulting and Engineering field project, give the Office location managing the project as well as the project/location.

Report No.: Optional numbering field for offices/projects.

FW Supervisor: The Foster Wheeler (FW) Supervisor responsible for the work effort involving the incident. Do not give a subcontractor supervisor or craft foreman name. If a Foster Wheeler Supervisor was the Affected Employee, this field should contain the name of his or her supervisor. The Supervisor is the project supervisor if the incident happens on a project, or the administrative supervisor if the incident happens in the office (e.g., a geologist, acting as a Field Operations Lead gets injured on a job site, or in a motor vehicle in the course of project work). The FW Supervisor is most likely the Project Manager. If the same geologist gets injured lifting a box in his office, the FW Supervisor is likely the Office Science Lead.

Location of Incident: The specific location on the project, in the office, or offsite location.

Weather Conditions: Temperature, precipitation, approximate wind speed and direction, cloud cover, relative humidity. This information may be included in the description section, and must be given in detail whenever it is a factor in the cause or impact, (e.g., spill, release, heat stress, wind blown material).

Describe What Happened: This section must be completed in sufficient detail to adequately describe the events and conditions leading up to and resulting from the incident. Try to answer the questions who, what, where, when, and how. This information is then used to determine why (cause). Provide details such as work objective, procedure being used, body position, and PPE. Include diagrams or sketches for all incidents involving vehicles/equipment and other incidents where they aid in providing detail or perspective. Consider attaching photographs. Follow the guidelines in Practical Loss Control Leadership, and consider the impact of each of the following:

P – **People**
E – **Equipment**
M – **Material**
E – **Environment**

To do an effective job, a visual inspection of the scene is usually necessary along with private interviews of affected employees and witnesses.

Where appropriate, use terms indicating the type of contact (e.g., struck by; struck against; fall from elevation; fall on same level; caught in; caught between or under; caught on; contact with; overstress; equipment failure; environmental release; fire).

Affected Employee Information

FWENC Employee: Direct hire, whether professional, administrative, or craft; full-time or part-time; permanent or temporary. If the affected employee is not a Foster Wheeler Environmental Corporation (FWENC) employee, give the name of the employer and business relationship (e.g., client, subcontractor, etc.) in the description section above.

Hours Worked on Shift Prior to the Incident: Only include the amount of time the employee worked that shift or day prior to the incident.

Years with FWENC: For FWENC employees, give the number of years employed with FWENC. If the employee has worked for FWENC for less than a year, do not write <1. Give the answer in fraction of year, or specify the number of months.

Injury/Illness Information

Nature of Injury or Illness: If the incident resulted in an injury or illness, give a brief description of the body part affected and type of injury or illness (e.g., fractured thumb, left hand; carpal tunnel syndrome, right hand).

First Aid Provided: First Aid is any treatment that does not have to be provided by a health care professional, even if it is (e.g., a laceration that is cleaned and bandaged in a clinic may constitute first aid, if sutures are not given).

Will the Injury Result In: Do not delay the report if this information is unknown.

Medical Treatment Information

Was Medical Treatment Provided? Medical treatment is that treatment that must be provided by a licensed medical practitioner, e.g., sutures, prescription medication, etc.

Type of Treatment: This information is important in determining OSHA recordability, since some forms of treatment would not constitute a Recordable case (e.g., one-time administration of prescriptions, negative diagnostic exams). Attach a copy of the treating professional's statement/work release.

Vehicle and Property Damage Information

Vehicle/Property Damaged: For vehicles, indicate VIN and whether it is company owned or leased, business trip rental (e.g., Avis) or owned by others.

Description of Damage: Be specific as to the identity of damaged part, location and extent.

Spill and Air Emissions Information

Substance Spilled or Released: For pure substances, list materials by common name/chemical. For wastes, indicate waste code. For mixtures or contaminated media, provide contaminant name, CAS No., concentration.

Reportable Quantity (RQ) Exceeded? Contact your Environmental Safety and Quality (ESQ) representative for guidance. Specify the RQ for the material, whether you answer yes or no.

Reportable to Agency? If yes, specify the federal, state or local agency that must be provided with verbal and/or written notification.

Written Report? Answer yes if the release requires a written report to be filed and note the time frame.

Response Action Taken: Describe the mitigation efforts, as well as any reports made, beyond initial notification.

L · 3157

Permit Exceedence

Type of Permit: List name of permit including the agency name where applicable (e.g., NPDES, State EPA).

Date of Exceedence: Specify date exceedence occurred (e.g., date discharge in excess of permit limits occurred).

Date First Knowledge of Exceedence: Specify date when first knew there was an exceedence (i.e., date analytical received). This date may be different from the date of the exceedence listed above.

Permitted Level or Criteria: List numerical discharge or emission limit or narrative criteria specified in the permit (e.g., 20% opacity limit, Best Management Practices [BMP] implementation per Storm Water Pollution Prevention Plan [SWPPP]).

Exceedence Level or Criteria: Specify actual numerical discharge/emission limit or narrative criteria which was exceeded (e.g., 22% opacity, failure of BMPs [silt fencing collapse] per SWPPP).

Exceedence Duration: Specify time frame by date and hours (using military time) during which exceedence occurred.

See **"Spill/Release Information"** (above) for description of remaining questions.

Persons Preparing Report

Employee's Name: The affected employee should review the report and sign here, as well as other employees witnessing or involved in the incident.

Supervisor's Name: The FWENC Supervisor must review and sign the report indicating agreement. The FWENC Supervisor and the Investigator should be the same person.

Investigative Report

Report No.: This is the same as the project optional report number from page 1 of the Incident/Near Miss Report.

Date of Investigative Report: This date should be within 72 hours of the incident. In cases where the investigation is not completed until a later date, submit the incomplete report within the 72 hours, and a revised report should be submitted when the missing information is obtained.

Incident Cost: For all vehicle/equipment or property damage cases, an estimated or actual loss value must be entered. If an estimated value is entered, the report must be revised when the actual costs are known.

OSHA Recordables: This section should be completed in consultation with the Project Environmental and Safety Manager (PESM). If it cannot be determined at the time of the report, the PESM should consult with the Foster Wheeler Director, Health and Safety Programs and revise the report when a determination is made.

No. of Restricted Days: This relates to days of restricted work activity, not restrictions on motion or physical capability. If the employee is capable of doing his normal job the day after the injury and

thereafter, there are no restricted days, even if the physician indicates a physical restriction. It does not include the day of the injury.

No. of Days Away from Work: The number of days after the day of the injury that the employee was scheduled to work but could not due to an occupational injury. If the treating physician releases an employee to return to work, but the employee chooses not to come to work, do not count those days. In this case, the PESM should contact the Foster Wheeler Director, Health and Safety Programs.

Cause Analysis

Immediate Causes: Determine the immediate causes, using the examples provided. If one or more of the examples fits the circumstance, use those words in the cause description. This facilitates statistical analysis of the incident database for program evaluation/modification. However, do not confine your cause determination to the guide words. Explain, for example, Improper Lifting – employee attempted to lift box by bending at the waist and twisting while lifting. Be sure that the incident description is sufficiently detailed to support the causal analysis in this section. An assumption of cause (e.g., improper lifting) from the injury (low back pain) is not acceptable.

Basic Causes: Like the Immediate Causes, use the guide words in the attachment whenever appropriate and explain. For example, improper motivation may be because the correct way takes more time or effort; short cutting standard procedure is tolerated or positively reinforced; or the person thinks there is no personal benefit to always doing the job correctly.

Note: The investigator is encouraged to review the Practical Loss Control Leadership chapters on *Causes and Effects of Loss* and *Accident/Incident Investigation* before doing the causal analysis. As a check, the investigator may refer to the S.C.A.T. Chart available from the PESM.

Remedial Actions: Include all actions taken or those that should be taken to prevent recurrence. Be sure that actions address the causes. For example, training (safety meetings) may be a necessary response for lack of knowledge, but may be inadequate for improper motivation. If completion dates exceed the 72 hours reporting period, a revised report must be submitted when all remedial actions are complete.

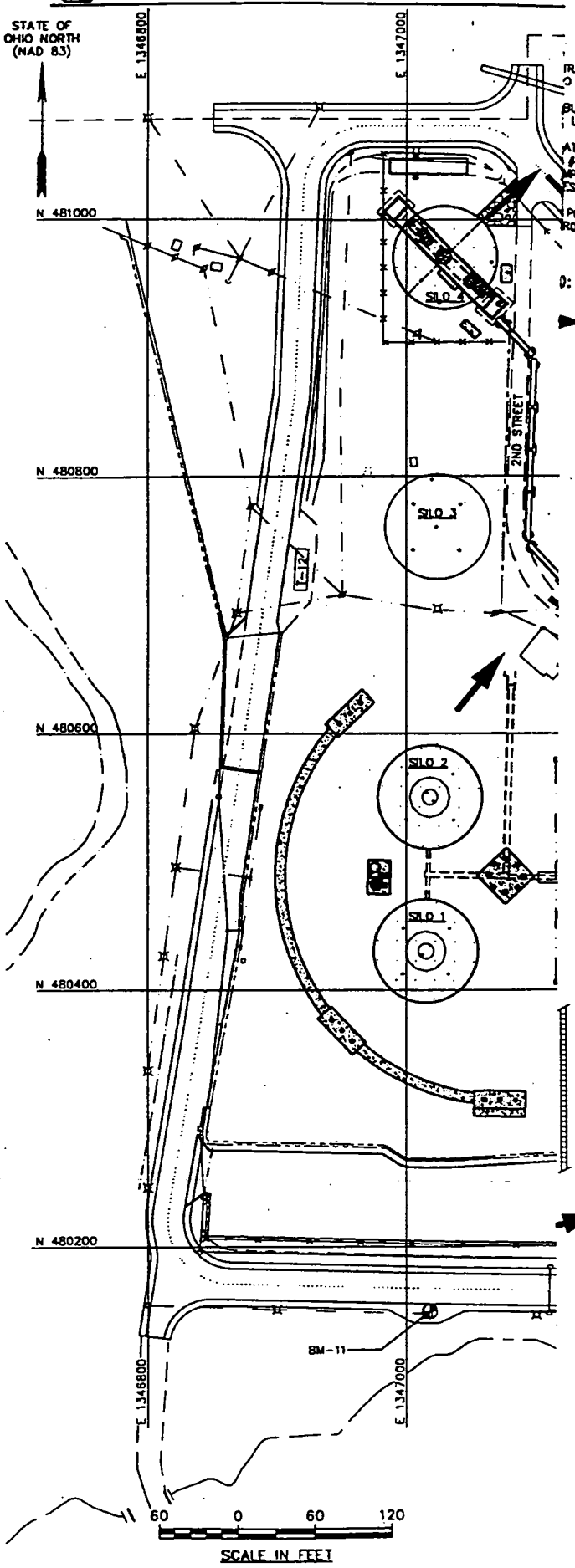
Persons Performing Investigation: The primary investigator is the FWENC Supervisor in charge of the work where the incident occurred. Others participating in the investigation, such as the Project Manager, Environmental and Safety Supervisor, Quality Control, site engineer, foreman, etc. should also sign the report.

Management Review: The Project or Office Manager and the PESM or office Environmental and Safety Coordinator (ESC) must sign the report indicating their satisfaction with thoroughness of the investigation and the report, and their concurrence that the action items address the identified causes. This constitutes the peer review, and the report, particularly the description, should be clear to readers not familiar with the project or incident.

APPENDIX C

AWR Project Area
Personnel Evacuation Routes and Rally Points

000272



TRAILER WILL HAVE AT LEAST ONE FIRE EXTINGUISHER RATED
0 LBS. ABC.

BLE EMERGENCY EYEWASH STATIONS AND DRENCH SHOWERS
LOCATED WITHIN 150 FT. OF WORK AREA.

ATED PERSONNEL TO ASSEMBLE AT PRIMARY FEMP RALLY
#4 IN THE EVENT OF AN EMERGENCY, AND WILL PROCEED
MP RALLY POINT #6 IF DIRECTED BY EMERGENCY COORDINATOR
SIGNEE). STAND CLEAR OF RESPONDING VEHICLES.

POINTS ARE APPROXIMATE LOCATIONS TAKEN FROM
ROCEDURE EM-0030.

EVACUATION ROUTES

FEMP RALLY POINT #6 (Alternate)

FEMP RALLY POINT #4 (Primary)

PERSONNEL EVACUATION ROUTES AND RALLY POINTS

3157

APPENDIX D

AWR Project
Bomb Threat Checklist (Typical)

000274

Bomb Threat Checklist (Typical). 3157

Listen. Do not interrupt the caller.

Your name	Time	Date
Caller's identity	Sex M F	Approximate age (years)

Origin of call
Local ☐ Long Distance ☐ Booth ☐

Voice Characteristics and Background Noises (Circle each appropriate description)

Voice	Speech	Language	Accent	Manner	Background Noises
Loud	Fast	Excellent	Local	Calm	Office machinery
High Pitch	Distinct	Fair	Regional	Rational	Factory machinery
Raspy	Stutter	Good	Eastern	Coherent	Bedlam
Intoxicated	Slurred	Obscene	Midwestern	Deliberate	Animals
Soft	Slow	Poor	New England	Angry	Quiet
Deep	Distorted		Southern	Irrational	Mixed
Pleasant	Nasal		**Race**	Incoherent	Street traffic
			Foreign	Emotional	Airplanes
			Asian	Laughing	Party atmosphere
			European		Trains
			Spanish		Music
					Voices

Describe any characteristics or noises not listed above: _____

Keep the caller talking.

If the caller is willing to keep talking, ask these questions:

When will it go off: Certain hour: _____ Time remaining: _____

Where is it planted? Building area: _____

What kind of bomb? _____

Where are you now? _____

How do you know so much about the bomb? _____

What is your name and address? _____

Hold on the line while you notify supervisor listed here: _____
Supervisor

Did the caller appear familiar with the site or building by his description of bomb location? _____

Write out the message in its entirety and any other comments below. _____

Action to take immediately after the call. _____

Notify the following persons in the order given:

1. Name _____ Phone No. _____
2. Name _____ Phone No. _____
3. Name _____ Phone No. _____

3157

APPENDIX E

AWR Project Contingency Plan
Glossary

3157

GLOSSARY

Accident (Operational): An event stemming from technological and man-made hazards which presents a potential threat to life, health, property, or the environment.

Assistant Emergency Duty Officer (AEDO): The Fluor Fernald emergency management authority onsite when the EOC is not operational. Incident commander of the FEMP emergency response activities.

Classification Levels –

> **Loggable Event:** A non-routine event, which is not required to be reported to DOE. It must, however, be recorded (along with all events of higher classification) in a log maintained by the operating contractors. This log will be available to DOE and contractor management for trend analysis and review as a part of the functional appraisal process.
>
> **Off-Normal:** Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in the safety, security, environmental or health protection performance or operation of a facility.
>
> **Unusual Occurrence:** A non-emergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations.

Deputy Emergency Director (DED): The immediate successor to the Fluor Fernald Emergency Director. The DED's primary emergency responsibility is the direction and control of emergency incidents as the manager of the EOC.

Detector: A material or device that is designed to be sensitive and can produce a response suitable for measurement or analysis.

Dose: The amount of energy deposited in tissue (unit = rad).

Dose Equivalent: The dose multiplied by a quality factor (QF). QF for Beta and Gamma is one; for Alpha it is twenty (unit = rem).

Dosimeter: A portable measuring device, normally worn by personnel at a nuclear facility, for measuring and registering the total accumulated exposure to ionizing radiation.

Dosimetry: The theory and application of the principles and techniques involved in the measure and recording of radiation doses. Its practical aspect is concerned with the use of various types of radiation instruments with which measurements are made. These measurements permit records to be kept on each individual exposed to a radiation environment.

Drill: Supervised instruction for testing, developing, and maintaining skills in a particular response operation. A drill may be a component of an exercise.

Effective Dose Equivalent: The summation of organ dose equivalents multiplied by organ-specific weighting factors (unit = rem).

000277

Emergency: Any significant deviation from planned or expected behavior or course of events, which could endanger or adversely affect people, property, or the environment.

Emergency Chief: The Fluor Fernald shift Safety and Fire Inspector who leads the Emergency Response Team.

Emergency Director (ED): The Fluor Fernald President or his designee has overall authority and responsibility for activities at the FEMP, including emergency management.

Emergency Duty Officer (EDO): Trained Fluor Fernald senior management personnel responsible for the management and oversight of the FEMP emergency response activities until the FEMP EOC is declared operational.

Emergency Equipment: Any equipment that may be required to measure, control, or mitigate the consequences of an emergency.

Emergency Management Organization: The FEMP EOC Staff, Emergency Duty Officers, and Assistant Emergency Duty Officers, and the offsite Emergency Management Organization.

Emergency Operations Center (EOC): The command and control center designed and equipped for directing and coordinating emergency response actions, located in the Administration Building.

Emergency Plan: A clear and concise description of the overall emergency organization, designation of responsibilities, and descriptions of the procedures, including notifications, involved in coping with any or all aspects of a potential credible emergency.

Emergency Planning Zone (EPZ): The geographic area surrounding the FEMP for which planning and preparedness efforts are carried out to ensure prompt and effective protective actions can be taken to reduce adverse effects of an emergency at the FEMP.

Emergency Procedure: Detailed instructions and guidance for carrying out emergency response actions.

Emergency Resources: Any individual or group of individuals, items of equipment or instrumentation, and specialized services which have been assembled, organized, or developed for the purpose of assisting in alleviating the consequences of an emergency.

Emergency Response Team (ERT): A group of professional and volunteer personnel trained for event mitigation, including emergency response to fire, hazardous materials release, radiological release, and medical emergencies. Members must meet specific physical, medical, and training requirements.

Event: Any significant deviation from planned or expected behavior or course of events that could endanger or adversely affect people, property, or the environment.

Exercise: An event that tests the integrated capability and a major portion of the basic elements of emergency preparedness as specified in emergency plans and procedures.

Facility Owner: The Fluor Fernald person designated as building custodian or the senior supervisor on-shift in a plant.

Health Physics: The science concerned with recognition, evaluation, control, and management of health hazards from ionizing radiation.

3157

Incident: For the purposes of this Contingency Plan, an incident is:

- An injury or illness which meets the OSHA recordability criteria,
- An exposure to a hazardous substance above the allowable exposure unit,
- A property/vehicle/equipment/heavy equipment/truck/passenger damage case which results in damage greater than $500,
- A fire or explosion,
- A spill or release resulting from FWENC, or subcontractor activities, including spills or releases from operations at a client facility of which FWENC employees have become aware,
- A permit exceedence, or
- A "near miss" or an event that has a reasonable probability in resulting in one the outcomes described above if the circumstances were different and for which modifications to management programs will reduce the probability of occurrence or the severity of the outcome.

Joint Information Center (JIC): The Fluor Fernald facility equipped to receive, coordinate, and disseminate emergency information to the media from the state, counties, and the FEMP.

Mutual Aid Agreement: A formal, written understanding between jurisdictions, which covers methods and types of assistance available during all phases of an emergency.

National Warning System: A full period voice telephone circuit used by the National Warning Center for the direct and simultaneous dissemination of warning information.

Natural Radiation: Also called "background," it is found naturally in the environment and includes cosmic rays and radiation from the naturally radioactive elements outside and inside the bodies of humans and animals.

Notification: Communication within mandated time frames of general information on the nature and severity of an emergency event.

Planning Zone: An area for which planning is done to assure that prompt and effective actions can be taken to protect onsite personnel, the public health and safety, and the environment in the event of a major emergency.

Plume: The profile of a gaseous or liquid release as it moves or disperses.

Protective Action: Physical action, such as sheltering or evacuation, taken to prevent potential health hazard from affecting employees or the offsite population potentially impacted form a hazardous materials release.

Rally Point: A designated safe location for personnel assembly when local evacuation is ordered. A number of locations around the FEMP are designated as rally points for the collection of, management of, and communications with personnel from evacuated facilities.

Reporting: Either (1) communicating, in any medium, further information on any event; or (2) preparing and submitting a written report on event according to established DOE policies and procedures.

Sheltering: An in-place, immediate protective action which calls for people to close all doors and windows, turn off all sources of outside air, listen to radio or television for emergency information, and remain indoors until official notification that it is safe to go out.

Telecommunication: Any transmission, emission, or reception of signs, signals, writings, images, and sounds or intelligence of any nature by wire, radio, visual, or other electromagnetic.

3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

DRAFT

Silo Penetration and Riser Installation Plan

DOCUMENT NO.
624-P622-63, Rev. 0

FOR THE
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

SUBMITTED TO:

FLUOR FERNALD

CONTRACT NO. FSC 624

May 18, 2000

Revision	Prepared by	Reviewed by	Approved by	Date
0				5-18-00

000281

3157

CONTENTS

1.0 PENETRATION REQUIREMENTS 3
- 1.1 Penetrations Cut From Bridges 3
- 1.2 Penetrations Cut From Dome 3

2.0 SAFETY CONSIDERATIONS 4
- 2.1 Permits/authorization 4
- 2.2 Platforms and Worker Support 4
- 2.3 Personal Protection Equipment 4
- 2.4 RCS Ventilation Control 5
- 2.5 Polyurethane Foam Removal 7
- 2.6 Plywood Removal 7
- 2.7 Securing of Concrete Before Removal 7
- 2.8 Concrete Sawing 8
- 2.9 Lifting 8
- 2.10 Materials 8
- 2.11 Waste Management 9
- 2.12 Silo Dome Loading 9

3.0 SILO 4 (FSMS) 11
- 3.1 Base Plate Installation 11
- 3.2 Cutting Operations 11
- 3.3 Riser Installation 13

4.0 SILOS 1 AND 2 14
- 4.1 Base Plate Installation 14
- 4.2 Cutting Operations 15
- 4.3 Riser Installation 17

5.0 REFERENCES 18

ATTACHMENTS:

SKFMD002, Anchor Cable Details
SKFMD003, Camera Riser Assembly
SKFMD005, Riser Base Plate
SKFMD006, EMMA Penetration Details
SKFMD008, Silo 4 EMMA Riser Assembly
SKFMD009, Silos 1 & 2 EMMA Riser Assembly
SKFMD010, Silos 1, 2, & 4 Camera Riser Aluminum Cover
SKFMD011, Silos 1, 2, & 4 48" Riser Aluminum Cover
SKFMD012, Silos 1,2, & 4 Camera Penetration Cutting Detail
SKFMD013, Silos 1, 2 & 4 36" Riser Aluminum Cover
SKFMD014, Silos 1, 2, & 4 Slurry Riser Subassembly
SKFMD015, Silos 1, 2, & 4 Camera Riser Subassembly
SKFMD016, Silo 4 EMMA Riser Subassembly
SKFMD017, Silos 1, 2, & 4 Sluicer Riser Assembly
SKFMD018, Silos 1, 2, & 4 Slurry Riser Assembly
SKFMD019, Silos 1 & 2 EMMA Riser Subassembly
SKFMD022, Silos 1, 2, & 4 Sluicer Riser Subassembly

000282

3157

ACRONYMS

cfm	cubic feet per minute
DAC	Derived Air Concentration
EMMA™	Easily Manipulated Mechanical Arm™
FSMS	Full-Scale Mock-Up System
ft	feet
FWENC	Foster Wheeler Environmental Corporation
L	liter
lb	pound
µCi	microCurie
min	minute
OSHA	Occupation Safety and Health Administration
PDC	Protective Dome Cover
pCi	picoCurie
PPE	Personal Protection Equipment
RCS	Radon Control System
RCT	Radiological Control Technician
TRD	Technical Requirements Document

000283

3157

1.0 PENETRATION REQUIREMENTS

To permit the deployment of equipment into the silos, new risers will be installed in the domes of Silos 1, 2, and 4. A total of six new penetrations will be required in each of the silos; a penetration for the Easily Manipulated Mechanical Arm™ (EMMA™), sluice equipment, slurry equipment and three for cameras. These penetrations will be cut using the bridges (existing Silo 4 bridge and new Silos 1and 2 bridge) as working platforms before the equipment modules are installed on the bridges. The bridges will also be used to determine the location of the new penetrations. The camera penetrations can be made by standing on the silo dome. The Radon Control System (RCS) will be operational before any cutting takes place.

Silo 4 penetrations will be made first to allow operation of the Full Scale Mock-up System (FSMS). The operations for making Silo 4 penetrations can be found in Section 3.0. It will also give the construction crews experience in cutting the silo domes and installing risers before they make penetrations in Silos 1 and 2. The operations used on Silos 1 and 2 will be identical to those used on Silo 4 where possible. Silo 2 penetrations will be made next followed by Silo 1. The operations for making Silos 1 and 2 penetrations can be found in Section 4.0.

1.1 Penetrations Cut From Bridges

New penetrations in each silo will be cut from working platforms on the bridges as described below:

1.1.1 Penetration 1

The new penetration required for the EMMA™ module will be located in the center of the silo dome. This penetration is to be 36-inch-diameter. The existing riser on top of the Silos 1 and 2 will not be used because it is not centered on the dome. A new riser will be installed concentric with the bridge opening. On Silo 4, the existing riser located in the center of the silo will be removed and a new 36-inch riser installed.

1.1.2 Penetration 2

The penetration for the sluicing module is an enlargement of the penetration for an existing 20-inch-diameter riser. The module opening in the bridge will determine the center of this penetration. The existing riser will be removed and a new 36-inch-diameter riser installed.

1.1.3 Penetration 3

The penetration for the slurry module is an enlargement of the penetration for an existing 20-inch-diameter riser. The module opening in the bridge will determine the center of this penetration. This existing riser will be removed and a new 48-inch-diameter riser installed.

1.2 Penetrations Cut From Dome

New penetrations in each silo will be cut while standing on the dome are described below:

000284

- 3157

1.2.1 Camera Penetrations

Three new penetrations are required in Silo 4 for the cameras. The camera penetrations will be located approximately 120° apart and will be 12-inch-diameter. To avoid blind spots in the silos, cameras will not be located in line with the bridge or the equipment modules.

2.0 SAFETY CONSIDERATIONS

2.1 Permits/authorization

Limiting conditions for operation (Preliminary Hazard Analysis Report, Section 5.5) require that no loads be placed on the silo dome in excess of 700 pounds and that equipment loads should be distributed over the largest area possible. Also, fall protection is required for personnel. This requirement is met by estimating the loads to be placed on the dome in advance of the intended activities. The details about the activity and the results of the calculations are used to complete a Silo Dome Access Permit. Fluor Fernald approval of the Silo Dome Access Permit is required before any work begins on the dome.

Other requirements are (1) only one penetration can be worked at a time, and (2) that the concrete pieces being removed shall be secured to prevent falling should it break loose during cutting. All work will be done in accordance with a safe work plan.

2.2 Platforms and Worker Support

2.2.1 Under-bridge platform

Temporary platforms will be constructed as needed under the bridge for use during the silo penetration and riser installation process.

2.2.2 Fall Protection

Workers will be wearing full-body harnesses and be tied-off to the bridge using lifelines in accordance with Fluor Fernald and OSHA requirements.

2.2.3 Dome Surface Access

Workers will only work from the silo surface while installing the camera risers. A maximum of two workers equipped with one hydraulic ring saw will work from the silo dome at this time to minimize dome loading.

2.3 Personal Protection Equipment

Personal Protection Equipment (PPE) requirements will be specified on work permits appropriate to the task, e.g. flame, penetration. Most permits are prepared by FWENC for Fluor Fernald approval. Radiation work permits prepared in the field by Fluor Fernald Radiological Control personnel. The following sections identify the expected PPE requirements.

000285

3157

2.3.1 Respiratory Protection

Radon concentrations in the Silo at equilibrium (after operation of the RCS) will be approximately 3 E+5 pCi/L (or 3 E-4 µCi/mL). This is about 40 times the Derived Air Concentration (DAC) for radon without daughters. Supplied-Air Respirators will be worn inside the containment structure and powered air-purifying respirators will be worn elsewhere around the silos.

2.3.2 Coveralls/hood/shoecovers/gloves

Tyvek™ (or equivalent) coveralls, shoecovers, hood, and gloves will be required—in addition to the respiratory protection equipment—for work in the containment structure and for work installing the camera risers.

2.4 RCS Ventilation Control

RCS ventilation control will be used as the primary method for controlling radon during silo penetration and riser installation.

2.4.1 Optimization of RCS

Before the start of the silo penetration activities, the RCS will have been operating and the concentration of radon inside the silo will have been reduced approximately two orders of magnitude (e.g., from about 20,000,000 pCi/L to about 300,000 pCi/L). The nominal airflow from each silo will be 250 cfm, with a maximum additional capacity of 1000 cfm available by controlling the RCS fan bypass damper. The flows in the system will be adjusted so that when a silo is first penetrated, the flow from the other silo and the fan bypass damper will be diverted so that a maximum amount of air enters the silo through the new penetration. This will maximize the velocity of the inlet air and minimize the chance for radon release. Figure #1 illustrates the optimization of the RCS for making silo penetrations.

000286

L - 3157

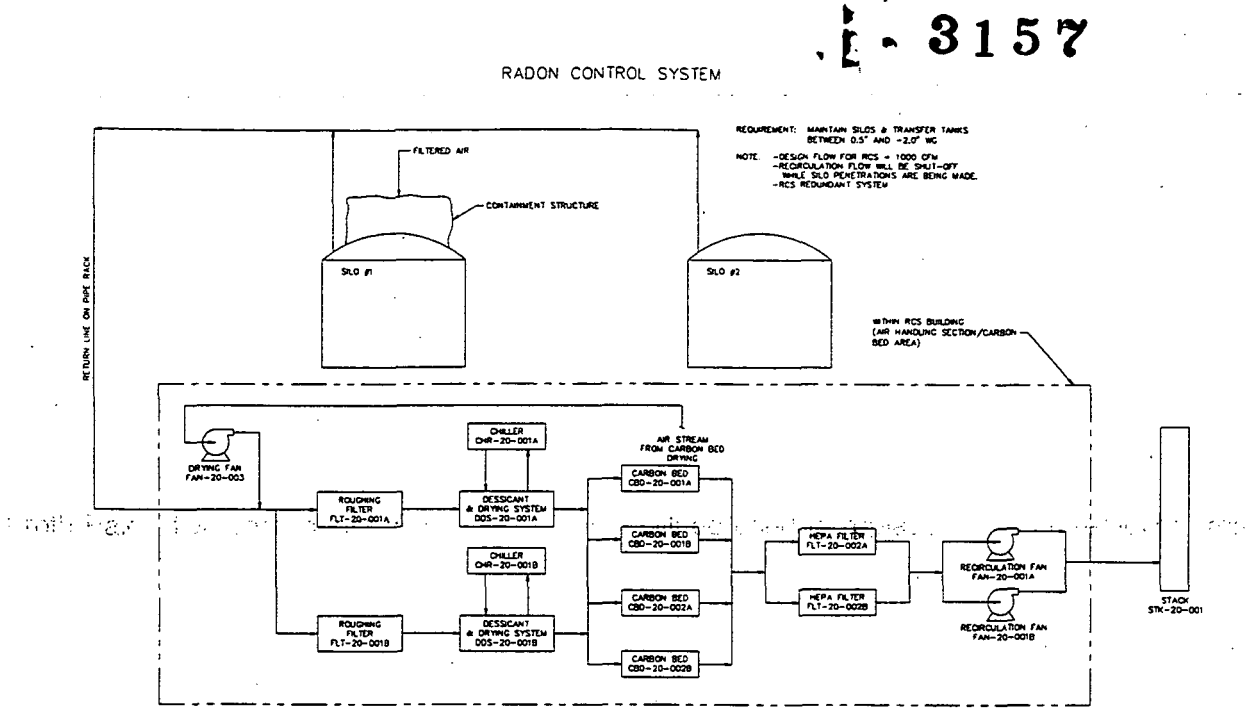


Figure #1
RCS Optimization for Silo Penetration

2.4.2 Containment Structure

The capacity of the RCS (1000-cfm) will not be sufficient to maintain the desired 150-ft/min flow into the silo during the larger penetration and riser installations. Therefore, a containment structure will be installed where the EMMA™, slurry pump and sluicer penetrations will be made. Containment structures will be built around the below-bridge platform and create an above-bridge room. Before silo penetration, the containment structure will be ventilated naturally. However, once penetration occurs air will be drawn out of the containment structure by the RCS. Inlet air for the containment structure will be fresh outside air drawn in through portals of limited aperture so that the desired inflow will be maintained greater than 25 ft/min.

The bottom of the containment structure will consist of plastic curtains held in place by tape, flashing, and/or sealant. This will seal the tent to the dome surface during silo penetration and riser installation activities. The portion of protective dome cover directly under the bridge will be contained within the containment structure.

The containment structure will be sized so that there is room on the bridge level to stage the riser initially and to size-reduce (if necessary) the debris from the silos. The packaging of silo debris in a 55 gallon drum for disposition as radioactive waste will occur in the above bridge room of the containment structure, and the jib crane will also operate from within the containment structure.

The capacity of the RCS is sufficient to maintain 25 ft/min through the camera penetrations during the riser installation. This is found from the equation;

$$Q = V \bullet A$$

3157

where

Q = volumetric flow rate (cfm)
V = velocity of air (ft/min)
A = Area of opening (ft^2).

By directing the full capacity of the RCS (1000 cfm) through the camera penetration, and knowing the penetration diameter of 1-ft (0.79 ft^2), the velocity of the air flowing through the penetration is found to be 1273 ft/min. This is a maximum flow rate if all of the RCS capacity is diverted through this opening. This velocity exceeds the requirement of 25 ft/min with a 50.9:1 safety factor. The containment structure will not be needed for making the camera penetrations because the face velocity requirements will be met for these openings.

2.5 Polyurethane Foam Removal

2.5.1 Bulk Removal

The polyurethane foam covering the silos will be removed only in locations necessary for installing and modifying risers. This foam will be removed by scraping and cutting and bagged for disposal. The bagged foam will be stored on the bridge temporarily.

2.5.2 Cleaning Foam Off of Concrete

After the bulk of the foam has been removed, the remainder will be removed using a needle scalar as necessary to establish a bondable surface. A shop/HEPA vacuum will be used in conjunction with the final surface preparation to capture any dust from the silo surface.

2.5.3 Waste Disposal

After the foam removal process is complete, all waste stored on the bridge will be placed in a 55 gallon drum and transferred to Fluor Fernald for disposal (see section 2.11).

2.6 Plywood Removal

The plywood covering the center chord of the protective dome covers on Silos 1 and 2 will be cut out after the foam is removed. During the removal, the plywood will be size reduced, bagged, and placed in drums on the bridge for disposal (see section 2.11).

2.7 Securing of Concrete Before Removal

2.7.1 Drilling of Sections to be Removed

See Section 3.2

2.7.2 Anchor Ropes

See Section 3.2.2

3157

2.7.3 Tie-Off

See Section 3.2.2

2.8 Concrete Sawing

2.8.1 Saw Support

A safety line will be attached to the cutting equipment during cutting operations made from the bridge. All safety lines will be secured to the bridge. The purpose of the safety line is to serve as a tether to aid the operator in handling the tools and for retrieval of tools from inside the silo should they be dropped.

2.8.2 Sizing

After the cut-outs are severed from the dome, they will be hoisted to the bridge and size reduced. They will then be placed in a drum and transferred to Fluor Fernald for disposal.

2.8.3 Dust Control and Slurry Disposition

The sawing and core drilling processes require water to be supplied to the tools for cooling. This will eliminate any dust from forming during the cutting processes. Most of this water/concrete slurry will fall into the silo. Any that remains on the surface of the silo dome will be wiped up after the cutting process is complete.

2.9 Lifting

2.9.1 Equipment

All lifting will be done with a jib crane (Equipment CRH-12-002) located on the bridge. Trained and qualified riggers will be used operate equipment in accordance with a critical lift plan that will be developed. A chain hoist (Equipment CRH-11-003) will be attached to the end of the jib crane to supply the amount of vertical travel required. The camera risers will be installed without the use of a crane since they weigh 30 lb.

2.9.2 Material Disposition

All equipment will be located inside the containment structure until the riser installation is complete. This includes jib crane/hoist, riser to be installed, 55 gallon drum(s) for waste disposal, and working space for size reduction before packaging. Plastic will be laid on the bridge surface before any waste is removed. This plastic and its contents will be disposed of as necessary to prevent the spread of contamination on the bridge.

2.10 Materials

Chemicals used during the installation of new risers that require special storage and application instructions are listed below. They have also been identified in the Hazardous Chemical List, Document 624-P8B371-01. This document will have Material Safety Data Sheets attached for each chemical and a copy of the document will be kept on site.

3157

2.10.1 Grout

Five Star Instant Grout™ will be used to install base plates for the new silo risers.

2.10.2 Sealant

Dow Corning 832 Multi-Surface Adhesive Sealant™ will be used for sealing joints.

2.10.3 Bonding Agent

Epoxy concrete-to-concrete bonding compound will be applied to silo domes before new grout is applied.

2.10.4 Polyurethane Foam

Froth-Pak™ two-component polyurethane foam will be used to replace old foam removed from silo domes where required.

2.10.5 Red Head Acrylic 7

Red Head Acrylic 7 will be used to anchor eyebolts to the camera penetration cutouts.

2.11 Waste Management

All waste generated during the silo penetration and riser installation process will be disposed of in accordance with Technical Requirements Document 40710-RP-0001 (Part 7, Section 5.0). This waste may include materials such as concrete, rebar, structural steel, wire mesh, plywood, and polyurethane foam.

After construction debris has been removed from the silo, it will be evaluated by a Fluor Fernald, Radiological Control Technician (RCT). If the RCT determines the waste is free-releasable, it will be transported to an off-site disposal facility by Foster Wheeler Environmental. If the waste is considered contaminated, it will be packaged in accordance with 49 CFR, Subchapter C (Part 7, Section 5.0) and DOE-NV-324 (Part 7, Section 5.0). Foster Wheeler Environmental Corporation will initiate a 65-card for the containers and place them in a waste holding area determined by Foster Wheeler Environmental Corporation. The containers will there await handling and transportation by Fluor Fernald. Before packaging, all construction debris will be size reduced in accordance with "Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility," 20100-PL-0014 (Part 7, Section 3.0).

2.12 Silo Dome Loading

The following section illustrates the method used to determine how much dead load is placed on the silo by the new risers that will be installed. The loads were determined using basic geometric relationships for volumes of cylinders and hollow cylinders. First, the volume of the concrete or steel being removed was determined. Credit was taken for materials removed in the final loading summary. The material density was then used to find the weight of the area removed. The weight of the riser being installed was then determined along with any additional concrete to be added or hardware being used. Table 1 shows the results of these calculations. The net dead loading of the silo domes from the new risers is 19 lb.

L- 3157

Table #1
Silo Dome Loading

	Riser	Slurry	EMMA FSMS	EMMA SWRS	Sluicer	Camera	
		48-inch	36-inch	36-inch	36-inch	12-inch	
Riser Dimensions	Density (lb/in^3)	0.28	0.28	0.28	0.28	0.28	
	O.D. (in)	48	36	36	36	12	
	I.D. (in)	47.76	35.76	35.76	35.76	11.782	
	Wall Thickness (in)	0.12	0.12	0.12	0.12	0.109	
	Riser Length (in)	31.17	19.17	41.67	31.17	16.25	
	Weight (lb)	157.536	72.605	157.821	118.053	18.527	
Flange Dimensions	O.D. (in)	52.125	40.125	40.125	40.125	16.125	
	I.D. (in)	48.125	36.125	36.125	36.125	12.125	
	Height (in)	2	2	2	2	1.25	
	Weight (lb)	30.75	23	23	23	3.88	
Riser Skirt Dimensions	Diameter (in)	77.9	55.56	47.25	63.69	30	
	Thickness (in)	0.25	0.25	0.25	0.25	0.25	
	Hole (in)	52	36	36	40	12	
	Weight (lb)	198.2	105.5	55.2	144.7	44.5	
Base Plate Dimensions	Length (in)	96	80		80		
	Width (in)	96	80		80		
	Thickness (in)	0.25	0.25		0.25		
	Hole (in)	54	50		50		
	Weight (lb)	169.7	108.7		108.7		
Clamps and Hardware	Weight (lb)	10	10		10		
Grout Bed	I.D. (in)	54	50		50		
	O.D. (in)	70	66		66		
	Height (in)	3.5	3.5		3.5		
	Weight (lb)	473	443		443		
	Riser Assm. Weight (lb)]	1040	763	236	847	67	
Concrete & Riser Removal	O.D. (in)	54	42	42	42	18	
	I.D. (in)	20	0	0	20	0	
	Height (in)	4	4	4	4	4	
	Conc. Weight (lb)	686	481	481	372	88	
	Exist Riser Weight (lb)	250	0	0	250	0	
	Total per silo (lb)	936	481	481	622	88	Total SWRS
Net Dead Load		**103**	**282**	**-245**	**225**	**-21**	**19**

3157

3.0 SILO 4 (FSMS)

3.1 Base Plate Installation

3.1.1 Overview

Base plates will be installed on the silo dome before the penetrations are cut into the silo dome. They will serve several purposes including: (1) securing the riser to the dome, (2) sealing the riser to the dome, (3) leveling and controlling elevation of the riser, and (4) distributing the riser load on the dome. They will also allow the riser to be installed on the silo dome where surface irregularities will be after the old risers have been removed. They will be constructed of continuous, ¼-inch aluminum plate to minimize weight. The base plate will have a hole through the center for cutting the penetration after it is installed and for installing the riser. The base plates will be installed with the existing riser protruding through them. Before base plates are installed on Silo 4, an annular ring of polyurethane foam will be sprayed onto the silo dome in the location of the future riser. This is to simulate the foam that is on Silos 1 and 2. Details of the base plates can be seen on FWENC Drawing SKFMD005.

3.1.2 Surface Preparation

Aligning with the module opening in the bridge, the center and the perimeter of the new penetration will be marked on the silo dome. A bonding agent will be applied to the silo dome to ensure adhesion of the grout bed, which will be described next.

3.1.3 Installation

An annular bed of grout will be applied around the perimeter of the future penetration. This will have an approximate radial width of 8 inch and be sufficiently thick to allow the base plate to rest entirely on the new bed and not the silo dome when installed. The base plate will have steel bolts attached to the bottom side, which will be pressed into the grout. These bolts will secure the base plate to the grout after the grout has cured. One of these 4 bolts is longer (Risers 2 and 3 only). This bolt will prevent the base plates from sliding down the surface of the silo domes until the grout has cured. The bolt prevents the base plate from sliding using a hole drilled approximately 2-inch deep in the silo dome. The bolt will be pressed through the grout into this hole. Backing material will be used to retain the grout while it is curing. The base plate will next be lowered into position and the locating bolt inserted into the drilled hole. The plate will be shimmed to a predetermined angle (16°) and will rest on the shims while the grout is curing.

3.2 Cutting Operations

3.2.1 Overview

Because of the deteriorated condition of the silo domes, (see Appendix H of TRD), special care will be given to minimize loading. To ensure that the silo dome loading does not exceed the 700 lb requirement, the workers will be standing on gangways located under the bridge. These gangways will also be used for riser maintenance that may be required such as connecting or disconnecting equipment risers. All equipment used for cutting will be placed on these gangways and not on the dome whenever possible. Calculations have been made to determine

the silo's integrity once the penetrations are made (see Calculation CA-FSC624-FS-003 in *Key Calculations,* Document 624-P622-63).

3157

The concrete and risers being removed will be prevented from falling into the silo once they are severed. After these pieces of concrete are removed, they will be size reduced, placed in drums and transferred to an Fluor Fernald RCT who will determine if the waste is free-releasable or contaminated (see Section 2.1). The new risers will then be installed and sealed.

All penetration cutting, except for the camera penetrations, will be done inside containment structures to simulate the process to be used on Silos 1 and 2.

3.2.2 Cutout Retention

Before the cutting process begins, the concrete to be removed must be secured to prevent it from falling into the silo. Because of the poor condition of the concrete, a compression-type concrete anchor cannot be trusted to prevent the cutouts from falling into the silo. An anchor may even cause the cutouts being removed to split apart, risking dropping the fragmented cutouts into the silo. The plan to capture the different types of cutouts is discussed below.

3.2.2.1 Imitation Dome

The EMMA™ module will be positioned over the center of the silo dome when in operation. No riser is located in the center of the silo dome on Silos 1 and 2 so a new one will be made. There is, however, an existing riser on Silo 4. To simulate the same cutting operations used on Silos 1 and 2, a test apparatus will be built offsite. This apparatus is described below.

An imitation section of a silo dome will be constructed offsite for demonstrating the ability cut a penetration with the protective dome covers in place. After the imitation dome is made, lumber will be used to construct the equivalent of the protective dome cover over the imitation dome. After the construction is complete, the cutting process will begin. The cutout for the simulated riser will be retained by drilling several holes through the dome and lowering anchor cables down through these holes (see Section 4.2.2.1).

3.2.2.2 Risers 1, 2, and 3 Penetrations

Risers 1, 2, and 3 will replace existing risers in Silo 4. An eyebolt will be attached to the existing riser before cutting begins. This eyebolt will then be attached to the jib crane mentioned in Section 2.9 and the slack will be removed from the rigging lines. Once the cutout is severed, it will be hoisted through the module opening in the bridge.

3.2.2.3 Camera Penetrations

There will be three camera penetrations in each silo located 120° apart. The camera penetrations will be made no further than 32-feet radially outward from the center of the silo dome to prevent cutting any of the structural rebar in the silo domes. A single cable will be attached to the center of the cutout to retain it after it is cut. The camera penetrations are located near a thicker section of the dome with more reinforcement. One or two workers using one 12-in diamond core drill (110 lb.) would be able to work from the surface of the silo dome to make these penetrations. No additional personnel or equipment will be allowed on the silo dome during this process to prevent loading in excess of the 700 pound requirement. Temporary scaffolding or a hydraulic man platform will be used to set up equipment and work

around the edges of the dome for camera riser installation and camera installation or removal. The cutouts will be hoisted out by hand; they will weigh less than 40 pounds.

L. 3157

The camera penetration cutouts will be retained using an eyebolt anchored to the cutout using Red Head Acrylic 7 adhesive anchoring system. This eyebolt will be installed before the core drill begins cutting. See FWENC Drawing SKFMD012 for more detailed retention instructions

3.2.2.4 Contingency Plan

If a piece of concrete weighing more than 40 pounds falls in to the silo, it will be retrieved later using EMMA™ during the Silo Debris Retrieval System (SDRS), see System Design Description (Document 624-P622-30) for details of SDRS.

3.2.3 Cutting Method

3.2.3.1 Ring Saw Cutting

The new penetrations will be located using the center of the module openings on the bridge. All penetrations will be shaped as close to a circle as possible using the cutting method detailed below.

The penetrations will be made using a water-cooled, hydraulically powered ring saw with a diamond blade. A Partner, Model K3600 has been selected for the cutting work. The saw is lightweight (17.4 lb) and compact, making it easy to operate and to reduce dome loading. The saw will be handheld and will not rest directly on the dome. The saw requires a portable hydraulic power pack, which will be located on the bridge. Three, approximately 30-feet-long hoses (two for the hydraulics and one for cooling water), will be run from the power pack and coolant pump to the saw. The cooling water must be supplied at less than 1 gpm. The cooling water will drain into the silos.

3.2.3.2 Core Drilling

The camera penetrations will be made using a core-drilling machine manufactured by Hilti. The drilling machine is model DD250E and is capable of drilling up 16-inch cores. The holes for the anchor cables will also be drilled with the DD 250E using an 2-inch diameter core bit. For anchor cable hole details, see FWENC Drawing SKFMD006.

3.3 Riser Installation

The design of the new risers will be similar to the existing risers. They will consist of round pipe protruding through both surfaces of the silo dome. The upper end of the riser will be flanged for attachment of equipment modules or sealing plates when not in use. For a general arrangement of the riser locations see FWENC Drawing 10FMD017.

3.3.1 Riser 1 (For EMMA™)

The riser for the EMMA™ penetration will set perpendicular to the silo surface on the center of the dome. The riser will be constructed of 36-inch I.D. pipe, with an 11-gauge wall thickness. The top of the riser will have a circular flange (constructed of 2x2x3/16-inch rolled angle) continuously welded to the pipe to ensure a positive seal. The riser will have a skirt (constructed of ¼-inch plate) for connecting and sealing the riser to the base plate. This skirt

L. 3157

will be welded to the riser on an angle that will match the angle of the base plate installed for this riser. Because of the weight of the risers, all handling of the risers will be done with the jib crane and hoist.

Sealant will be applied to the base plate interface flange and the riser will be lowered into position. The riser will be centered under the bridge module opening and secured to the base plate using heel clamps. For more details of Riser 1, see FWENC Drawing SKFMD008.

3.3.2 Riser 2 (For Sluicer)

Riser 2 will be positioned vertically in the silo to allow for ease of equipment installation and removal. It is made of 36-inch-I.D. pipe, with an 11-gauge wall thickness. The top of this riser will also have a circular flange (constructed from 2x2x3/16-inch rolled angle) continuously welded to the pipe to ensure a positive seal. The riser will have a skirt (constructed of 1/8-inch plate) for connecting and sealing to the base plate. This skirt will be welded to the riser on an angle that will match the angle of the base plate installed for this riser. It will be installed in the same manner as Riser 1. For more details of Riser 2, see FWENC Drawing SKFMD017.

3.3.3 Riser 3 (For Slurry)

The riser for the slurry pump will be installed in the same manner as Riser 2. The only difference is that it will be made from 48-inch-I.D. pipe with an 11-gauge wall thickness. For details of Riser 3, see FWENC Drawing SKFMD018.

3.3.4 Camera Risers

The three camera risers are the smallest of the risers to be installed. The inside diameter of these risers will be 12-inch with a 12-gauge wall thickness. They will have a circular flange continuously welded on top to positively seal the riser. This flange will mate with the camera flange. The camera risers will be secured directly to the silo dome using anchor screws. Caulk will be used to seal any air gaps that remain after the riser has been installed. The camera will be installed perpendicular to the silo dome since the cameras do not have to be mounted or inserted/extracted vertically. The elevation of the top of the risers is not critical because they will not be accessed by equipment on the bridge. Details for the camera risers can be seen on FWENC Drawing SKFMD003.

4.0 SILOS 1 AND 2

4.1 Base Plate Installation

4.1.1 Overview

Base plates will be installed on the silo dome before the penetrations are cut into the silo dome. They will serve several purposes including: (1) securing the riser to the dome, (2) sealing the riser to the dome, (3) leveling and controlling elevation of the riser, (4) distributing the riser load on the dome, (5) and minimizing worker expose after penetration is made. They will also allow the riser to be installed on the silo dome where surface irregularities will be after the old risers have been removed. They will only be used for Risers 2 and 3; Riser 1 will be attached to the existing Protective Dome Cover (PDC). They will be constructed of continuous, ¼-inch aluminum plate to minimize weight. The base plate will have a hole through the center for cutting the penetration after it is installed and for installing the riser. All workers will be wearing

PPE during these operations. Details of the base plates can be seen on FWENC Drawing SKFMD005.

3157

4.1.2 Surface Preparation

Aligning with the module opening in the bridge, the center and the perimeter of the new penetration will be marked on the silo dome. The rigid polyurethane foam covering on the domes will be removed only where the riser will be located. It will first be removed from the surface of the dome that will contact the base plate except for an area where the base plate will overlap the foam approximately 6-inch (see FWENC Drawing SKFMD017 and SKFMD018). This overlap will allow the existing foam to later be used as a form for applying grout. After the bulk of the existing foam is removed, a needle scalar will be used to remove the remaining foam and etch the existing concrete surface. See Section 2.5 for foam disposal. A bonding agent will be applied to the silo dome before the bed that will ensure the bed is secured to the silo dome.

4.1.3 Installation

An annular bed of grout will be applied around the perimeter of the future penetration. This will have an approximate radial width of 8-inch and be sufficiently thick to allow the base plate to rest entirely on the new bed and not the silo dome when installed. The base plate will have steel bolts attached to the bottom side, which will be pressed into the grout. These bolts will secure the base plate to the grout after the grout has cured. One of these 4 bolts is longer (Risers 2 and 3 only). This bolt will prevent the base plate from sliding down the surface of the silo domes until the grout has cured. The bolt prevents the base plate from sliding using a hole drilled approximately 2-inch deep in the silo dome. The bolt will be pressed through the grout into this hole. Backing material will be used to retain the grout while it is curing. The base plate will next be lowered into position and the locating bolt inserted into the drilled hole. The plate will be shimmed to a predetermined angle (16°) and will rest on the shims while the grout is curing.

4.2 Cutting Operations

4.2.1 Overview

See Section 3.2.1 for details. Penetrations for risers 1, 2, and 3 will be conducted inside a containment structure to guard against uncontrolled releases of radon.

4.2.2 Cutout Retention

See Section 3.2.2

4.2.2.1 Riser 1 Penetration

The EMMA™ module will be positioned over the center of the silo dome and PDC when in operation. There is not an existing riser in this location so a new one will be installed.

Some modifications will be made to the PDC before a new penetration can be made here. Before these modifications are made, the radon trapped under the PDC will be evacuated. This will be accomplished by drilling a 1-inch hole through the PDC and the silo dome at the same time. The hole through the PDC will immediately be plugged after the drill is removed. This will

allow the RCS to remove the radon trapped under the PDC before modifications are made to the PDC.

3157

The rigid polyurethane foam and plywood covering the 4-foot-diameter inner chord of the PDC will be removed next. The foam will be scraped off using hand tools and the plywood covering the 4-foot-diameter inner chord removed. After the inner chord is exposed, the W6×9 member will be removed from the center by unbolting it or with a grinder. See Drawings 34X-5500-S-00108, 34X-5500-S-00109, 34X-5500-S-00110 and 34X-5500-S-00111 for a detailed description of the PDC.

After the silo dome is accessible, six holes will be drilled through the silo dome on a 22 ¾-inch diameter (see FWENC Drawing SKFMD006) circle for the attachment of anchor cables. A jib crane and hoist will be centered over the EMMA™ module opening in the bridge and anchor chains will then be attached to the cutout and secured to the hoist for removing the cutout after it is severed. Details of the anchor cables can be seen on FWENC Drawing SKFMD002. The anchor cables are sized so that once they are lowered through the hole, they cannot slip back through the reinforcing mesh (will be added to simulate the actual silo dome construction) even if the concrete disintegrates around them. Using several anchors in each cutout will distribute the load, reducing the risk of the cutout collapsing under its own weight during the removal process. When the anchor cables have been secured to the dome they will then be attached to a rigging eye which will be suspended from the bridge using a jib crane (Equipment CRH-12-002) and chain hoist (Equipment CRH-11-003). The slack will be removed from the chain and anchor ropes to prevent the cutout from falling and abruptly stopping after it is severed. After the cuts have been made, the cutouts will be hoisted up onto the bridge and handled for disposal.

The penetration will be made in quarters to allow the cutout to be hoisted through the opening in the protective dome cover.

See Section 2.11 for waste disposal information.

4.2.2.2 Risers 2 and 3 Penetrations

Risers 2 and 3 will replace existing risers in the silos. An eyebolt will be attached to the existing riser before cutting begins. This eyebolt will then be attached to the same jib crane mentioned above and the slack will be removed from the rigging lines. After the cutout is severed, it will be hoisted through the module opening in the bridge.

See Section 2.11 for waste disposal information.

4.2.2.3 Camera Penetrations

There will be three camera penetrations in each silo located 120° apart. The camera penetrations will be made no further than 32-feet radially outward from the center of the silo dome to prevent cutting any of the structural rebar in the silo domes. A single cable will be attached to the center of the cutout to retain it after it is cut. The camera penetrations are located near a thicker section of the dome with more reinforcement. One or two workers using one 12-in diamond core drill (110 lb.) would be able to work from the surface of the silo dome to make these penetrations. No additional personnel or equipment will be allowed on the silo dome during this process to prevent loading in excess of the 700 pound requirement. It is more convenient to locate equipment on the surrounding berm rather than on the bridge to make the

camera penetrations. The cutouts will be hoisted out by hand; they will weigh less than 40 pounds.

3157

The camera penetration cutouts will be retained using an eyebolt anchored to the cutout using Red Head Acrylic 7 adhesive anchoring system. This eyebolt will be installed before the core drill begins cutting. See FWENC Drawing SKFMD012 for more detailed retention instructions.

See Section 2.11 for waste disposal information.

4.2.2.4 Contingency Plan

See Section 3.2.2.4

4.2.3 Cutting Method

See Section 3.2.3

4.3 Riser Installation

The design of the new risers will be similar to the existing risers. They will consist of round pipe protruding through both surfaces of the silo dome. The upper end of the riser will be flanged for attachment of equipment modules or sealing plates when not in use. For a general arrangement of the riser locations see FWENC Drawing 11FMD019.

4.3.1 Riser 1 (For EMMA™)

The riser for the EMMA™ penetration will set perpendicular to the silo surface on the center of the dome. The riser will be constructed of 36-inch I.D. pipe, with an 11-gauge wall thickness. The top of the riser will have a circular flange (constructed of 2x2x3/16-inch rolled angle) continuously welded to the pipe to ensure a positive seal. The riser will have a skirt (constructed of ¼-inch plate) for connecting and sealing the riser to the existing PDC. This skirt will have four holes predrilled through it for securing the riser to the PDC. Because of the weight of the risers, all handling of the risers will be done with the jib crane and hoist.

The riser will be centered under the bridge module opening and secured to the PDC by drilling and tapping the PDC to match the skirt of the riser. Sealant will be applied to the skirt and the riser will be lowered into position and secured using four bolts. After the riser is secured, a new layer of polyurethane foam will be applied to prevent water from pooling around the new riser. For more details of Riser 1, see FWENC Drawing SKFMD019.

4.3.2 Riser 2 (For Sluicer)

Riser 2 will be positioned vertically in the silo to allow for ease of equipment installation and removal. It is made of 36-inch-I.D. pipe, with an 11-gauge wall thickness. The top of this riser will also have a circular flange (constructed from 2x2x3/16-inch rolled angle) continuously welded to the pipe to ensure a positive seal. The riser will have a skirt (constructed of 1/8-inch plate) for connecting and sealing to the base plate. This skirt will be welded to the riser on an angle that will match the angle of the base plate installed for this riser.

Sealant will be applied to the base plate interface flange and the riser will be lowered into position. The riser will be centered under the bridge module opening and secured to the base plate using heel clamps. For more details of Riser 2, see FWENC Drawing SKFMD017.

4.3.3 Riser 3 (For Slurry)

3157

The riser for the slurry pump will be installed in the same manner as Riser 2. The only difference is that it will be made from 48-inch-I.D. pipe with an 11-gauge wall thickness. For details of Riser 3, see FWENC Drawing SKFMD018.

4.3.4 Camera Risers

The three camera risers are the smallest of the risers to be installed. The inside diameter of these risers will be 12-inch with a 12-gauge wall thickness. They will have a circular flange continuously welded on top to positively seal the riser. This flange will mate with the camera flange. The camera risers will be secured directly to the silo dome using anchor screws. Caulk will be used to seal any air gaps that remain after the riser has been installed. The camera risers will be installed perpendicular to the silo dome since the cameras do not have to be mounted or inserted/extracted vertically. The elevation of the top of the risers is not critical because they will not be accessed by equipment on the bridge. After the riser is secured, a new layer of polyurethane foam will be applied to prevent water from pooling around the new riser. Details for the camera risers can be seen on FWENC Drawing SKFMD003.

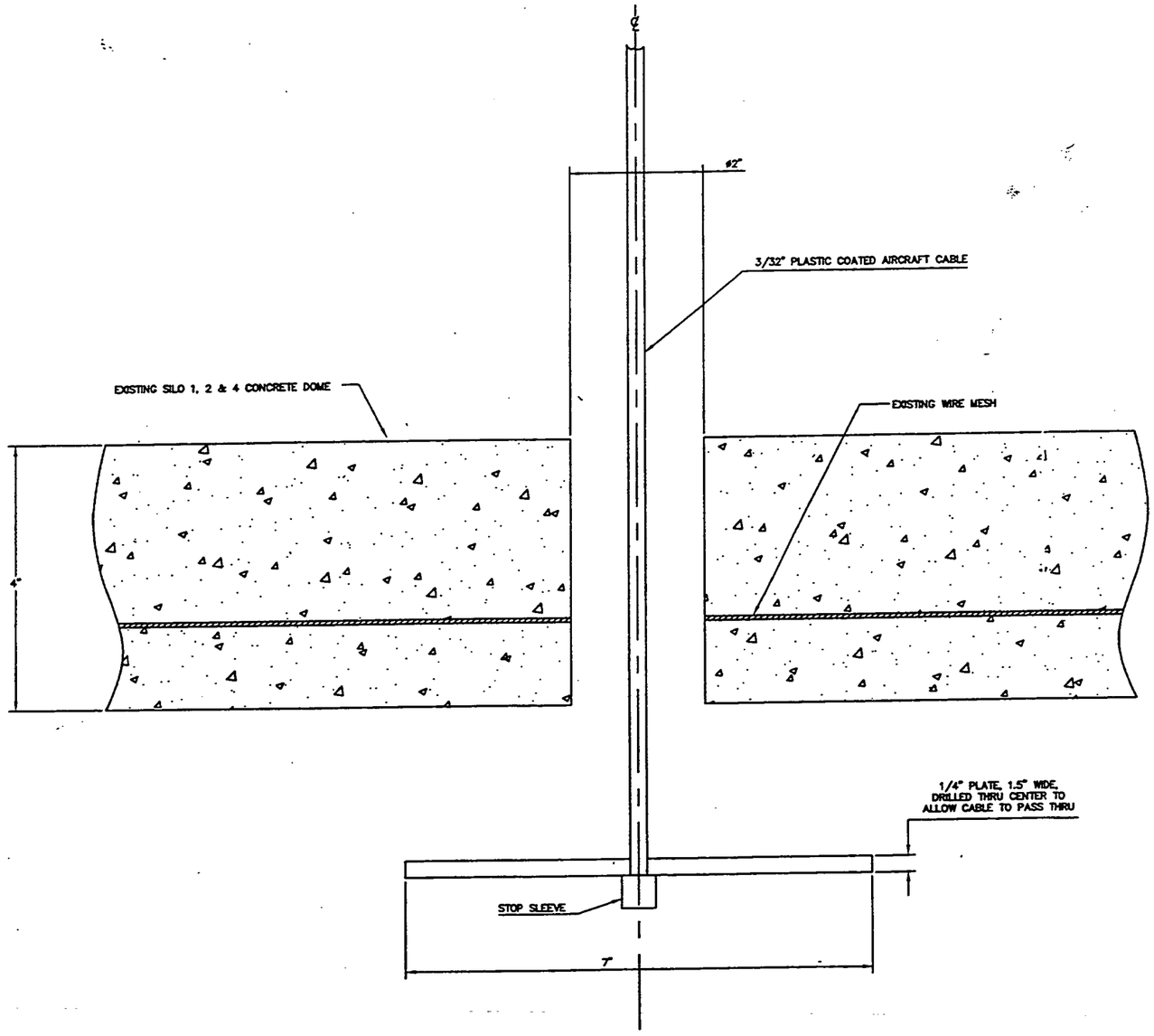
5.0 REFERENCES

Calculation CA-FSC624-FS-003; *Key Calculations* Document 624-P622-28
Drawing 10FMD017
Drawing 11FMD019
Drawing 34X-5500-S-00108
Drawing 34X-5500-S-00109
Drawing 34X-5500-S-00110
Drawing 34X-5500-S-00111
Hazardous Chemical List; Document 624-P622-101
OSHA
Preliminary Hazard Analysis Report; Document 624-P622-50
Technical Requirements Document; 40710-RP-0001

3157

NOTES:

1. LOCATE PENETRATIONS PER DRAWINGS 10FMD017 & 11FMD019.
2. MARK CENTER AND SIZE OF PENETRATION USING SILO BRIDGE TO LOCATE.
3. DRILL REQUIRED NUMBER OF 2" DIAMETER HOLES THRU SILO DOME (SEE SKFMD006).
4. INSTALL REQUIRED NUMBER OF ANCHOR CABLES THRU HOLES AND SECURE TO HOIST.
5. REMOVE SLACK FROM RIGGING LINES.
6. CUT CIRCULAR HOLE THRU SILO DOME USING A HYDRAULIC RING SAW.
7. HOIST CORE TO SILO BRIDGE OR SURROUNDING BERM.



TYPICAL LIFT POINT DETAIL
SCALE: FULL

000300

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 1, 2 & 4 ANCHOR CABLE DETAILS		
SIZE D	SCALE: FULL	DWG. NO. SKFMD002

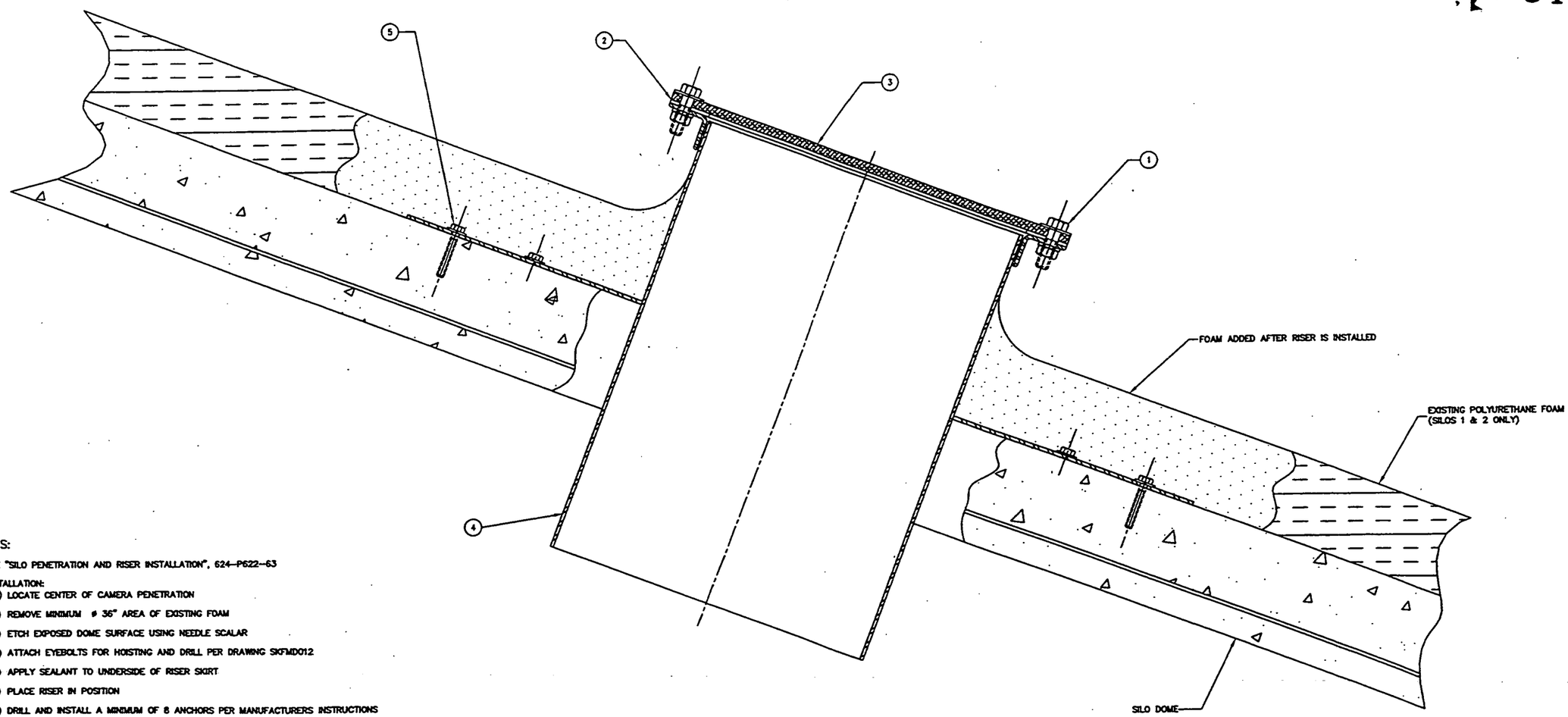
FILENAME: SKFMD002.DWG

MATERIALS LIST

MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	8	BOLT, 7/16-14 UNC, 1.50" LONG W/NUT	
2	1	NEOPRENE GASKET	
3	1	ALUMINUM COVER	DWG NO. SKFMD010
4	1	CAMERA RISER SUBASSEMBLY	DWG NO. SKFMD015
5	+	ANCHOR SCREWS, #1/4" X 1-3/4" LONG	

+ SEE NOTE "2G"

3157



ELEVATION

NOTES:

1. SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63
2. INSTALLATION:
   - 2A) LOCATE CENTER OF CAMERA PENETRATION
   - *2B) REMOVE MINIMUM ø 36" AREA OF EXISTING FOAM
   - *2C) ETCH EXPOSED DOME SURFACE USING NEEDLE SCALAR
   - 2D) ATTACH EYEBOLTS FOR HOISTING AND DRILL PER DRAWING SKFMD012
   - 2E) APPLY SEALANT TO UNDERSIDE OF RISER SKIRT
   - 2F) PLACE RISER IN POSITION
   - 2G) DRILL AND INSTALL A MINIMUM OF 8 ANCHORS PER MANUFACTURERS INSTRUCTIONS
   - 2H) CAULK ANY REMAINING AIR GAPS AT RISER/DOME INTERFACE
   - *2I) INSTALL NEW POLYURETHANE FOAM AND VAPOR BARRIER.
3. FOR RISER LOCATIONS SEE 10FMD017 & 11FMD019

* APPLIES TO SILOS 1 & 2 ONLY

000301

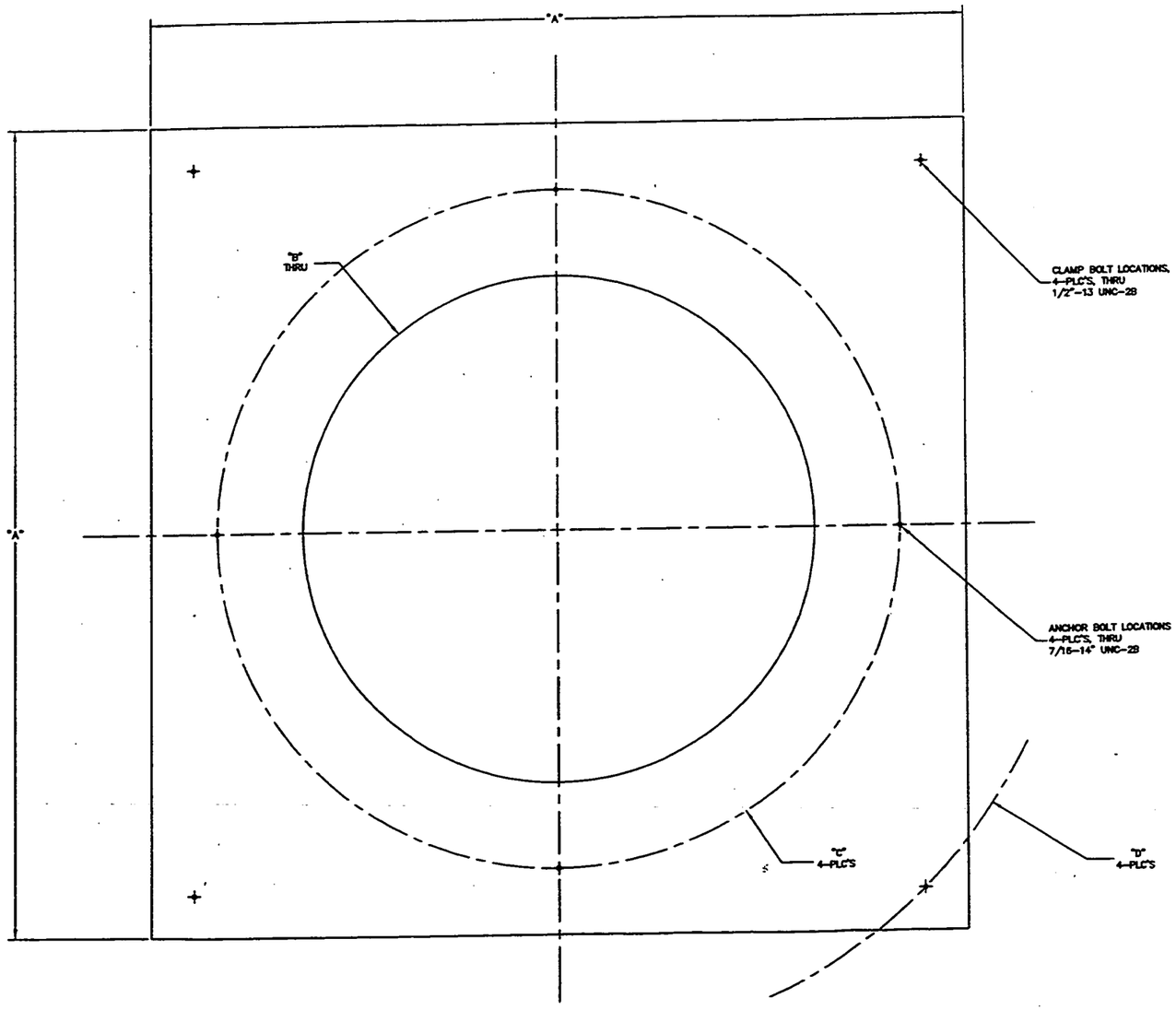
PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 1, 2 & 4 CAMERA RISER ASSEMBLY		
SIZE: D	SCALE: 6" = 1'-0"	DWG. NO. SKFMD003

FILENAME: SKFMD003.DWG

RISER	"A" (INCHES)	"B" (INCHES)	"C" (INCHES)	"D" (INCHES)
SLURRY	96.00	67.00 ø	37.24 R	39.72 R
SLURCER	80.00	50.00 ø	29.95 R	32.53 R
EMMA	80.00	45.00 ø	27.00 R	28.73 R

3157



PLAN

NOTES:

1. MATERIAL: 6061-T6, ALUMINUM PLATE, 1/4" THICK.
2. FOR BASE PLATE INSTALLATIONS, SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63.
3. SHARP EDGES TO BE DEBURRED.
4. TOLERANCES:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
5. ALL DIMENSIONS IN INCHES.

000302

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE: SILO 1, 2 & 4 RISER BASE PLATE

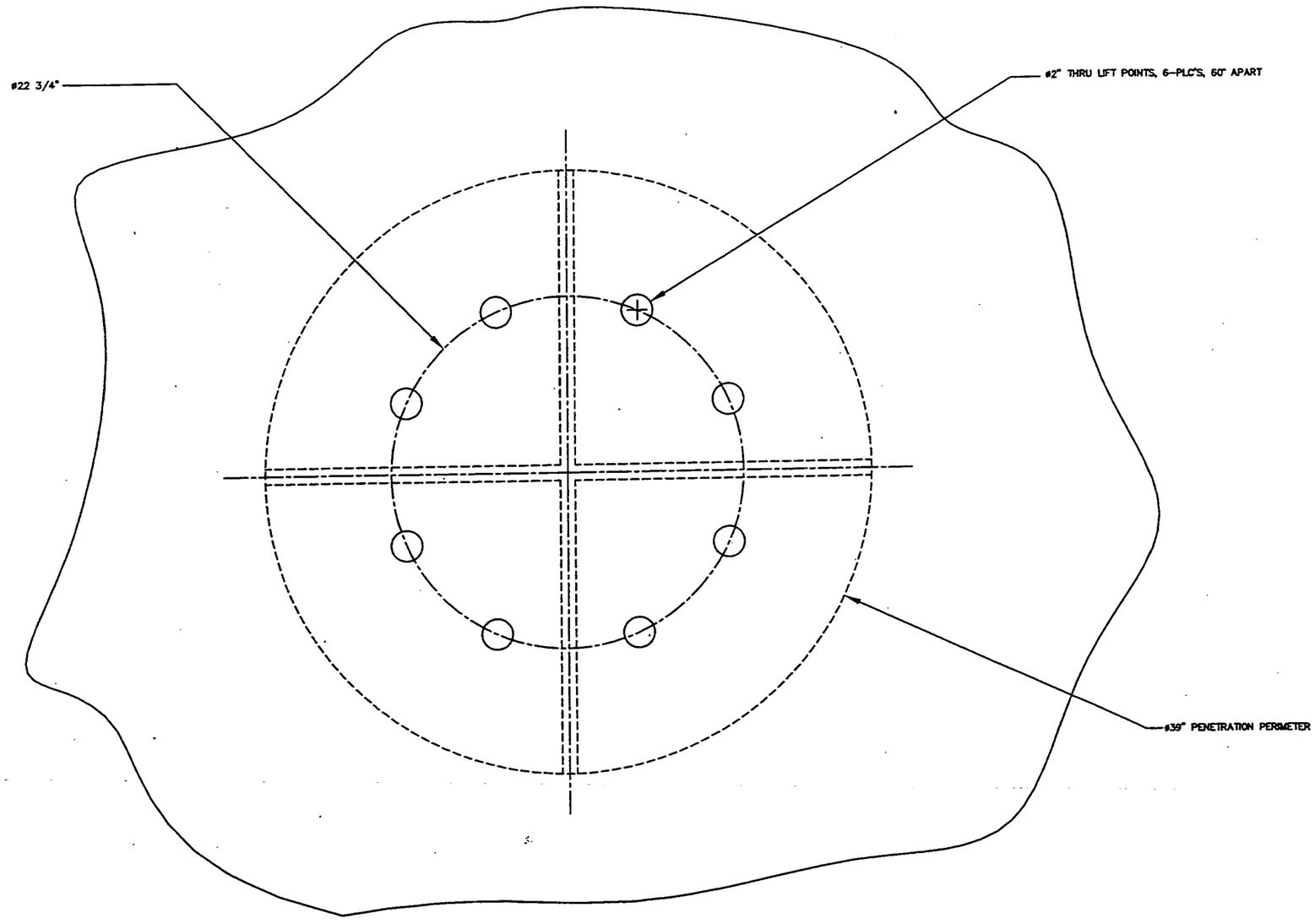
SIZE	SCALE:	DWG. NO.
D	1 1/2"=1'-0"	SKFMD005

FILENAME: SKFMD005.DWG

NOTES:

1. FOR PENETRATION CUTTING DETAILS & INSTALLATIONS, SEE "SILO PENETRATION AND RISER INSTALLATION PLAN", 624-P622-63
2. FOR PENETRATION LOCATIONS, SEE DRAWINGS 10FMD017 & 11FMD019

3157



TYPICAL EMMA PENETRATION
CUT VERTICALLY THRU DOME
PLAN

000303

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 4 SPARE, SILO 1 & 2 EMMA PENETRATION DETAILS		
SIZE D	SCALE: 3" = 1'-0"	DWG. NO. SKFMD006

FILENAME: SKFMD006.DWG

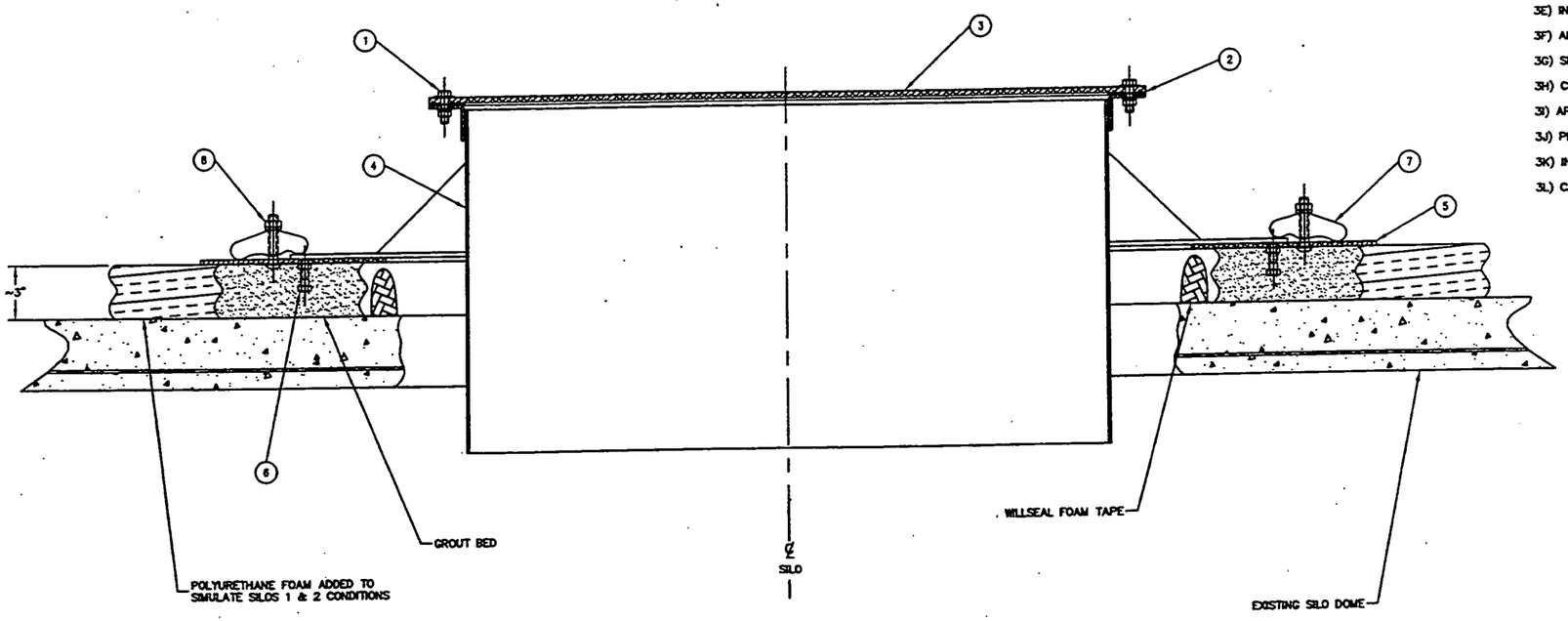
MATERIALS LIST

MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	16	BOLT, 7/16-14 UNC, 1.50" LONG	
2	1	NEOPRENE GASKET	DWG NO. SKFMD014
3	1	ALUMINUM COVER	DWG NO. SKFMD013
4	1	EMMA RISER SUBASSEMBLY	DWG NO. SKFMD016
5	1	BASE PLATE	DWG NO. SKFMD005
6	4	ANCHOR BOLTS, 7/16-14 UNC, 1.50" LONG	
7	4	5" HEEL CLAMP	PART NO. 3394A11
8	4	CLAMP BOLT, 1/2-13 UNC, 2.75" LONG	

E-3157

NOTES:

1. FOR RISER LOCATION SEE 10FMD017
2. SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63
3. INSTALLATION:
   - 3A) ROUGHEN CONCRETE
   - 3B) APPLY BONDING AGENT
   - 3C) INSTALL BACK-STOP MATERIAL
   - 3D) PLACE GROUT BED
   - 3E) INSTALL BASE PLATE AROUND EXISTING RISER
   - 3F) ALLOW GROUT TO CURE
   - 3G) SECURE EXISTING RISER
   - 3H) CUT OUT EXISTING RISER THROUGH CENTER OF BASE PLATE, SEE DWG SKFMD006
   - 3I) APPLY SEALANT TO UNDERSIDE OF NEW RISER SKIRT
   - 3J) PLACE NEW RISER IN POSITION
   - 3K) INSTALL HEEL CLAMPS
   - 3L) CAULK ANY REMAINING AIR GAPS AT RISER/DOME INTERFACE



ELEVATION

000304

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE
SILO 4
EMMA RISER ASSEMBLY

SIZE	SCALE	DWG. NO.
D	3" = 1'-0"	SKFMD008

FILENAME: SKFMD008.DWG

3157

NOTES:

1) MATERIALS:
   SKIRT: A36 HOT ROLLED STEEL PLATE
   RISER: A36 HOT ROLLED STEEL PLATE
   GUSSET: A36 HOT ROLLED STEEL PLATE
   FLANGE: CARBON STEEL, PURCHASE FROM KIRK & BLUM.

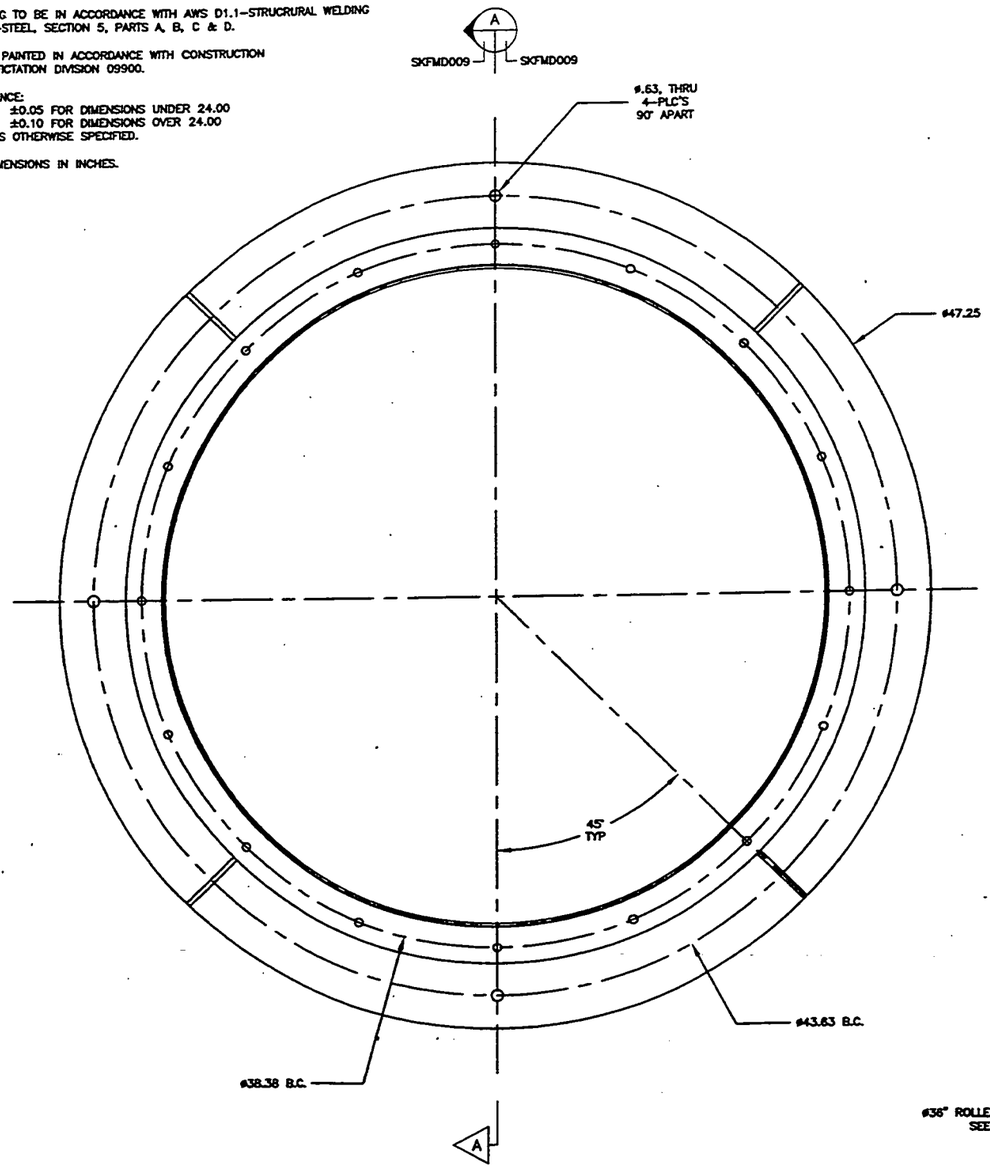
2) SHARP EDGES TO BE DEBURRED.

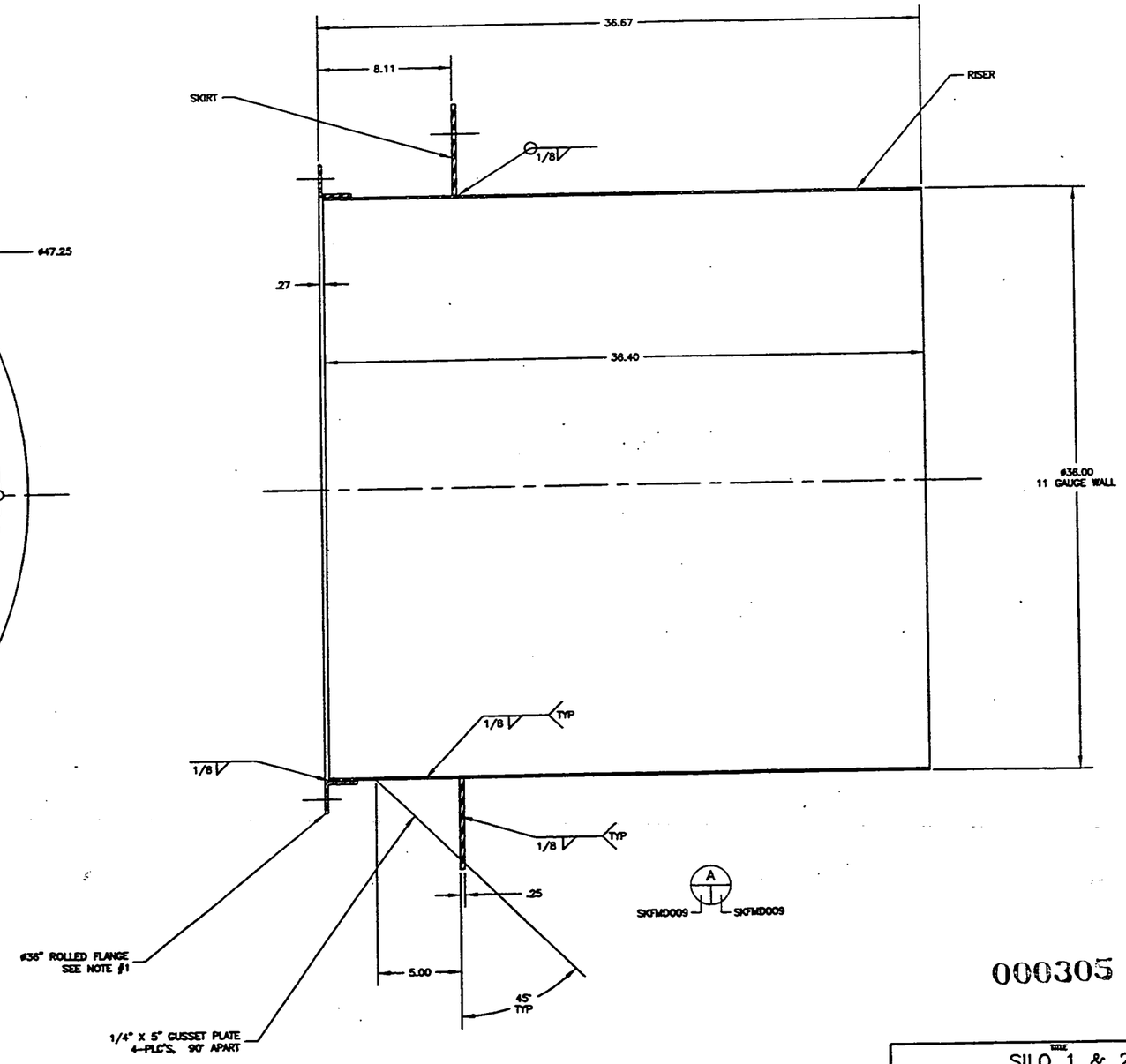
3) WELDING TO BE IN ACCORDANCE WITH AWS D1.1–STRUCRURAL WELDING CODE–STEEL, SECTION 5, PARTS A, B, C & D.

4) TO BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICTATION DIVISION 09900.

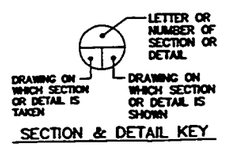
5) TOLERANCE:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
   UNLESS OTHERWISE SPECIFIED.

6) ALL DIMENSIONS IN INCHES.





000305



SECTION & DETAIL KEY

PRELIMINARY
NOT FOR CONSTRUCTION

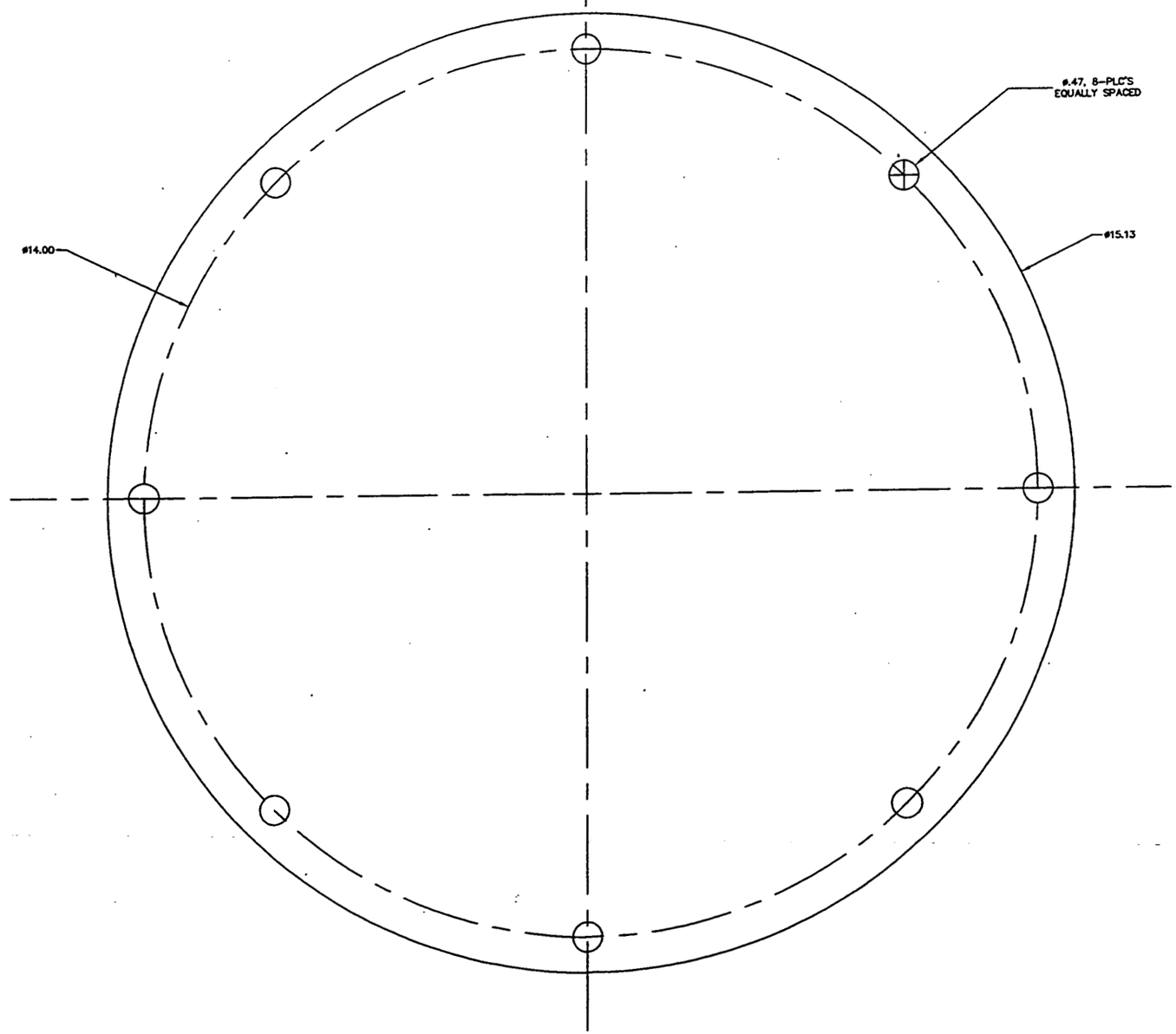
TITLE		
SILO 1 & 2 EMMA RISER SUBASSEMBLY		
SIZE D	SCALE: 3"=1'-0"	DWG. NO. SKFMD009

FILENAME: SKFMD009.DWG

3157

NOTES:

1. MATERIAL: 6061-T6 ALUMINUM PLATE, 5/16" THICK.
2. TOLERANCE:
   X.XX ±0.05
   UNLESS OTHERWISE SPECIFIED.
3. ALL DIMENSIONS IN INCHES.
4. SHARP EDGES TO BE DEBURRED.



PLAN

000306

PRELIMINARY
NOT FOR CONSTRUCTION

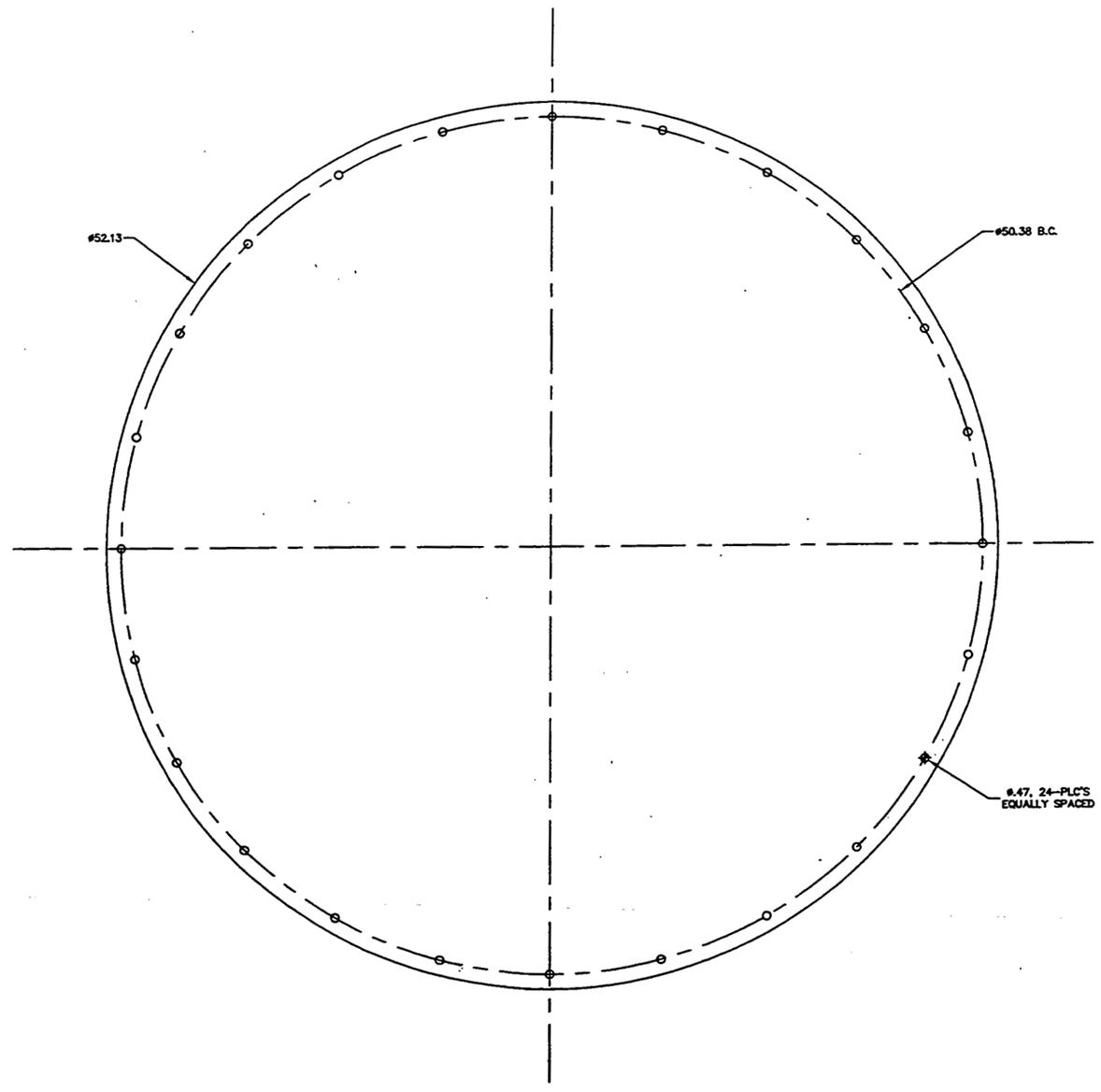
TITLE		
SILO 1, 2 & 4 CAMERA RISER ALUMINUM COVER		
SIZE: D	SCALE: FULL	DWG. NO. SKFMD010

FILENAME: SKFMD010.DWG

E - 3157

NOTES:

1. MATERIAL: 6061-T6 ALUMINU PLATE, 5/16" THICK.
2. SHARP EDGES TO BE DEBURRED.
3. TOLERANCES:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
4. ALL DIMENSIONS IN INCHES.



PLAN

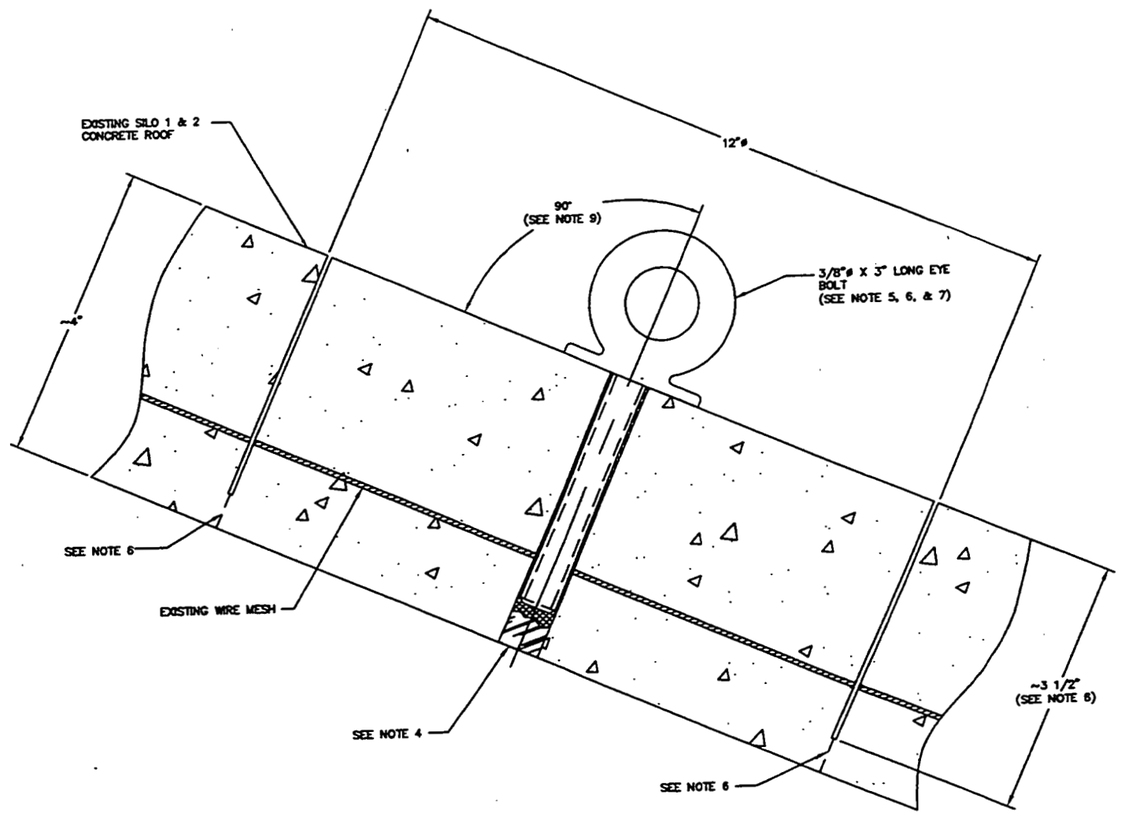
000307

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 1, 2 & 4 48" RISER ALUMINUM COVER		
SIZE: D	SCALE: 3"=1'-0"	DWG. NO. SKFMD011

FILENAME: SKFMD011.DWG

3157



ELEVATION

PENETRATION PROCEDURE

1. LOCATE INITIAL CENTER POINT FOR PENETRATION PER DRAWING 10FMD017 OR 11FMD019.
2. MARK CENTER POINT OF ø12" CORE DRILL. DRILL 1-ø7/16" COMPLETELY THROUGH THE SILO ROOF.
3. USING THE PREVIOUSLY DRILLED 7/16"ø HOLE. OBTAIN A THICKNESS MEASUREMENT OF THE SILO ROOF. IT IS ASSUMED THAT THIS THICKNESS WILL BE APPROXIMATELY 4".
4. STUFF BOTTOM OF THRU HOLE WITH WITH PAPER TOWELS OR EQUIVALENT BACKSTOP MATERIAL.
5. INSTALL 3/8"ø x 3" LONG THREADED EYE BOLT (SUPPLIED BY OTHERS) UTILIZING THE REDHEAD ACRYLIC 7 ADHESIVE OR APPROVED EQUAL. FOLLOW ALL MANUFACTURER'S RECOMMENDATIONS FOR USING THE ADHESIVE SYSTEM.
6. DRILL 12"ø CONCRETE CORE BY USING CORE CUTTING SYSTEM DD250E, AS MANUFACTURED BY HILTI OR APPROVED EQUAL. DRILL DEPTH TO BE 1/2" LESS THAN THE MEASURED THICKNESS OF THE SILO ROOF.
7. MOVE CORE DRILLING ASSEMBLY. ATTACH ROPE OR CABLE TO EYE BOLT. ROPE OR CABLE MUST BE ABLE TO SUPPORT THE ENTIRE WEIGHT OF THE CORE TO BE REMOVED. SECURE THE OTHER END OF THE ROPE OR CABLE.
8. REMOVE THE CONCRETE CORE BY PULLING ON THE ATTACHED ROPE OR CABLE STRIKING THE CORE WITH A SUITABLE HAMMER.
9. CORE DRILL TO BE PERPENDICULAR TO SILO ROOF.

000308

PRELIMINARY
NOT FOR CONSTRUCTION

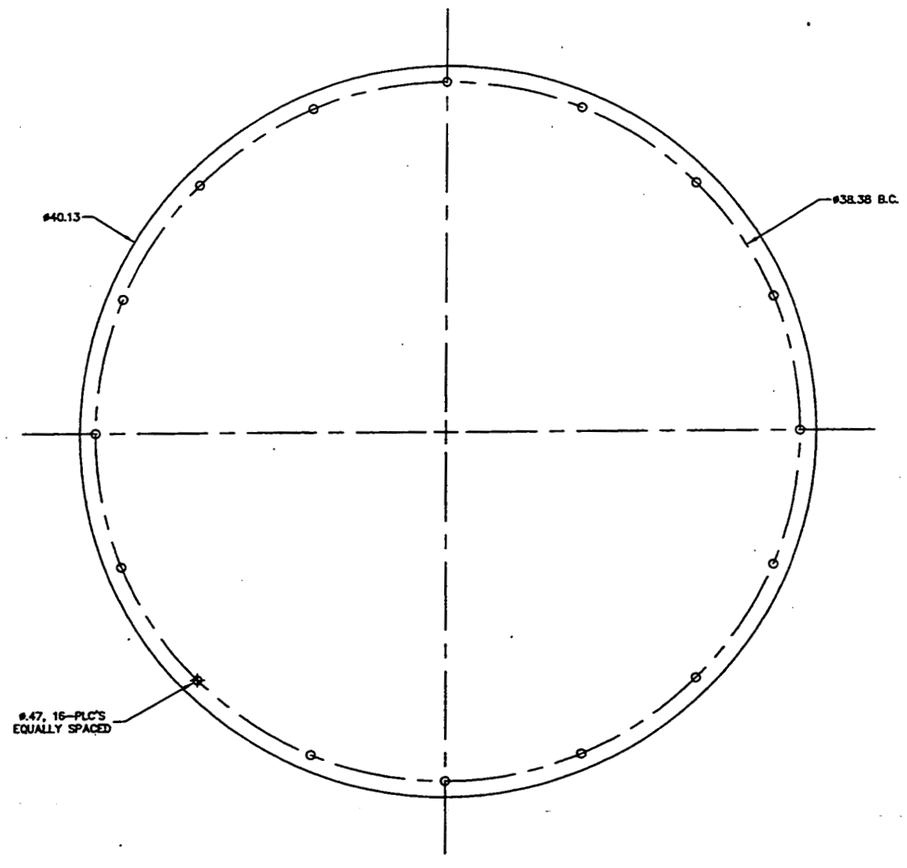
TITLE		
SILO 1, 2 & 4 CAMERA PENETRATION CUTTING DETAIL		
SIZE D	SCALE: FULL	DWG. NO. SKFMD012

FILENAME: SKFMD012.DWG

- 3157

NOTES:

1. MATERIAL: 6061-T6 ALUMINUM PLATE, 5/16" THICK.
2. SHARP EDGES TO BE DEBURRED.
3. TOLERANCES:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
   UNLESS OTHERWISE SPECIFIED.
4. ALL DIMENSIONS IN INCHES.



PLAN

000309

PRELIMINARY
NOT FOR CONSTRUCTION

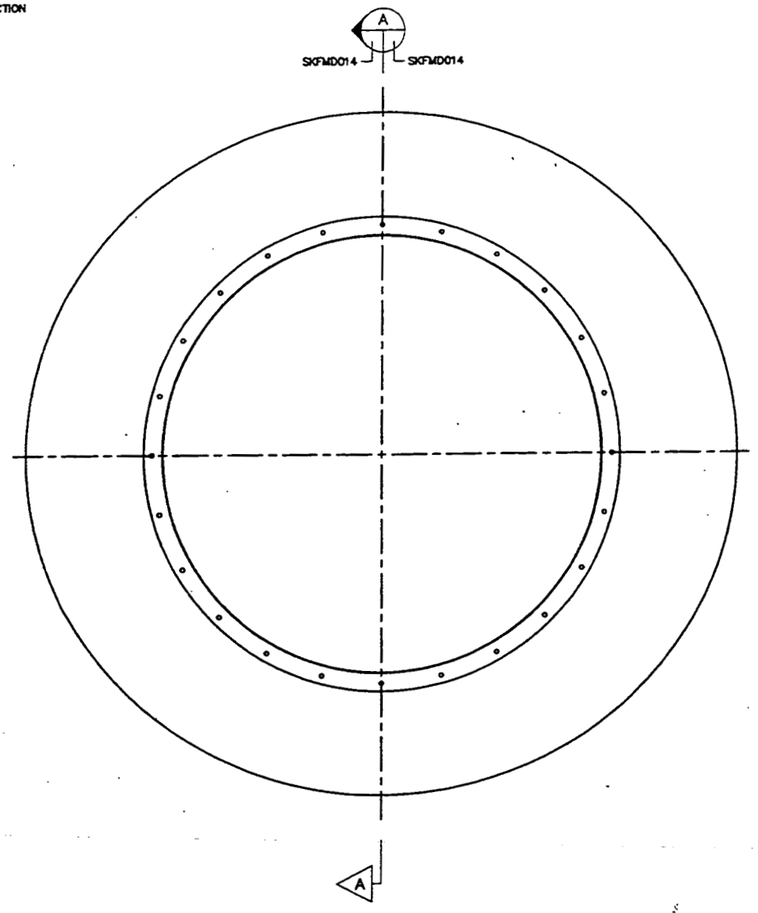
TITLE		
SILO 1, 2 & 4 36" RISER ALUMINUM COVER		
SIZE: D	SCALE: 3"=1'-0"	DWG. NO.: SKFMD013

FILENAME: SKFMD013.DWG

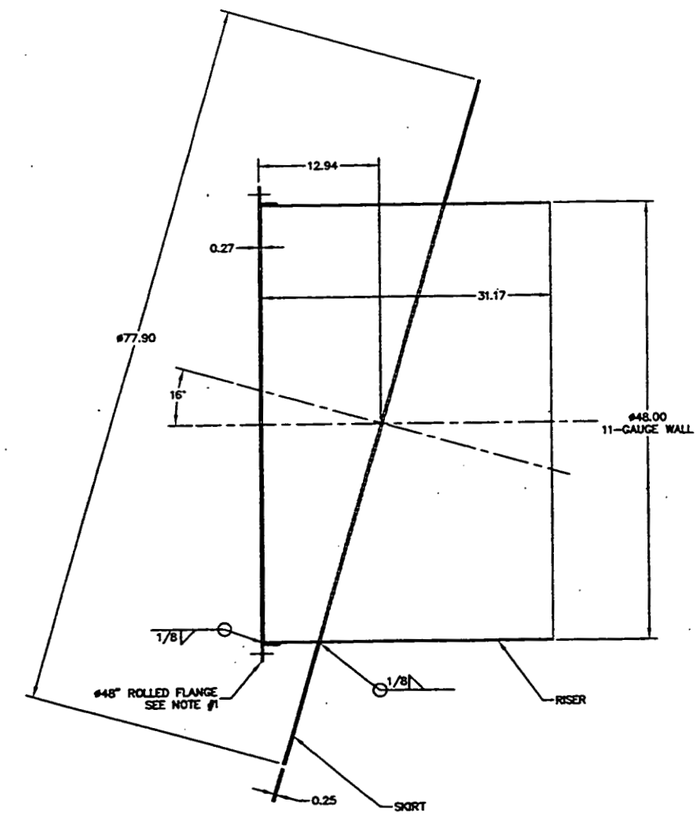
L-3157

NOTES:

1. MATERIALS:
   SKIRT: A36 HOT ROLLED STEEL PLATE
   RISER: A36 HOT ROLLED STEEL PLATE
   FLANGE: CARBON STEEL, PURCHASE FROM KIRK & BLUM.
2. SHARP EDGES TO BE DEBURRED.
3. WELDING TO BE IN ACCORDANCE WITH AWS D1.1-STRUCTURAL WELDING CODE-STEEL, SECTION 5, PARTS A, B, C & D.
4. TO BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION DIVISION 09900.
5. TOLERANCE:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
   UNLESS OTHERWISE SPECIFIED.
6. ALL DIMENSIONS IN INCHES.



PLAN



A SECTION
SCALE: 1-1/2"=1'-0"
SKFMD014 SKFMD014

000310

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

TITLE		
SILO 1, 2 & 4 SLURRY RISER SUBASSEMBLY		
SIZE D	SCALE: 1-1/2"=1'-0"	DWG. NO. SKFMD014

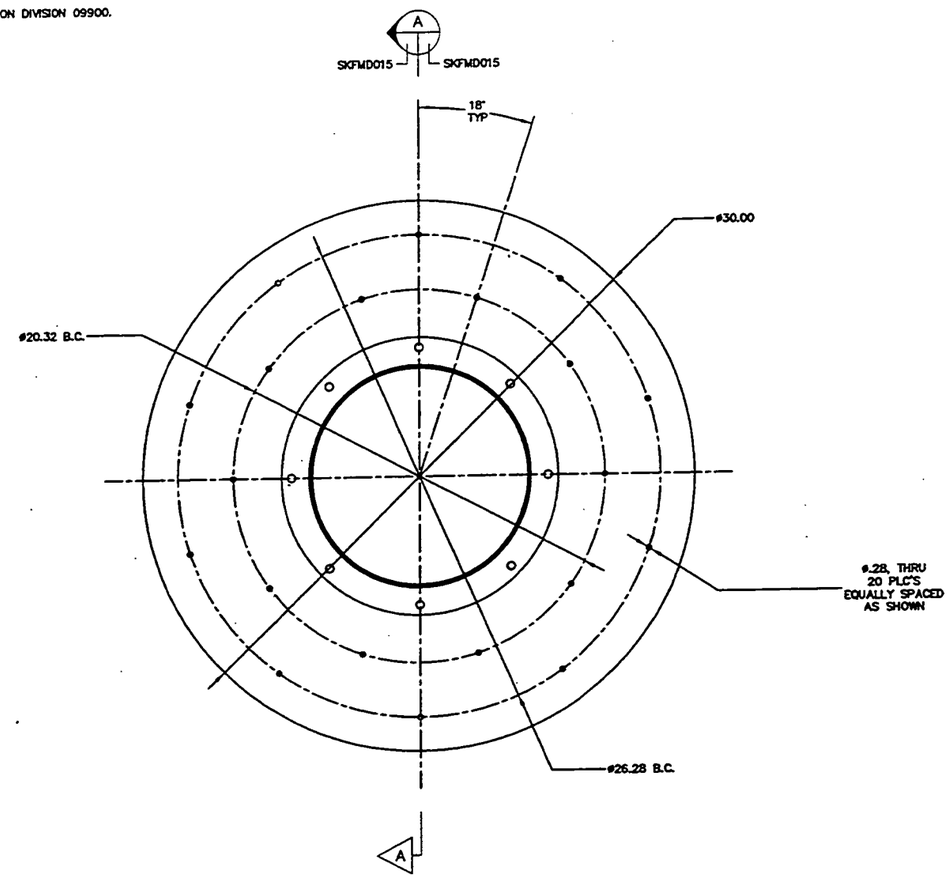
FILENAME: SKFMD014.DWG.

PRELIMINARY
NOT FOR CONSTRUCTION

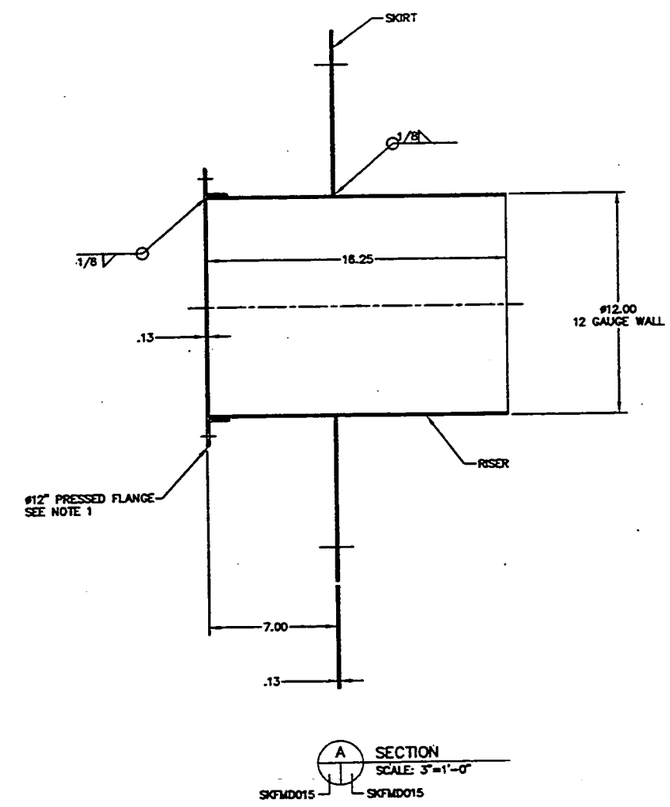
E-3157

NOTES:

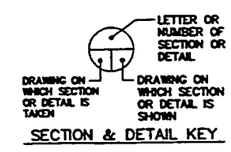
1. MATERIALS:
   SKIRT: A36 HOT ROLLED STEEL PLATE
   RISER: 1018 CARBON STEEL TUBE
   FLANGE: CARBON STEEL, PURCHASE FROM KIRK & BLUM
2. SHARP EDGES TO BE DEBURRED.
3. WELDING TO BE IN ACCORDANCE WITH AWS D1.1-STRUCTURAL WELDING CODE-STEEL, SECTION 5, PARTS A, B, C & D.
4. TO BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION DIVISION 09900.
5. TOLERANCES:
   X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
   X.XX ±0.10 FOR DIMENSIONS OVER 24.00
   X.XXX ±0.005
   ANGLES ±1°
   UNLESS OTHERWISE SPECIFIED.
6. ALL DIMENSIONS ARE IN INCHES.



PLAN



000311



SECTION & DETAIL KEY

TITLE		
SILO 1, 2 & 4 CAMERA RISER SUBASSEMBLY		
SIZE D	SCALE: 3"=1'-0"	DWG. NO. SKFMD015

FILENAME: SKFMD015.DWG

PRELIMINARY
NOT FOR CONSTRUCTION

3157

NOTES:

1) MATERIALS:
SKIRT: A36 HOT ROLLED STEEL PLATE
RISER: A36 HOT ROLLED STEEL PLATE
GUSSET: A36 HOT ROLLED STEEL PLATE
FLANGE: CARBON STEEL, PURCHASE FROM KIRK & BLUM

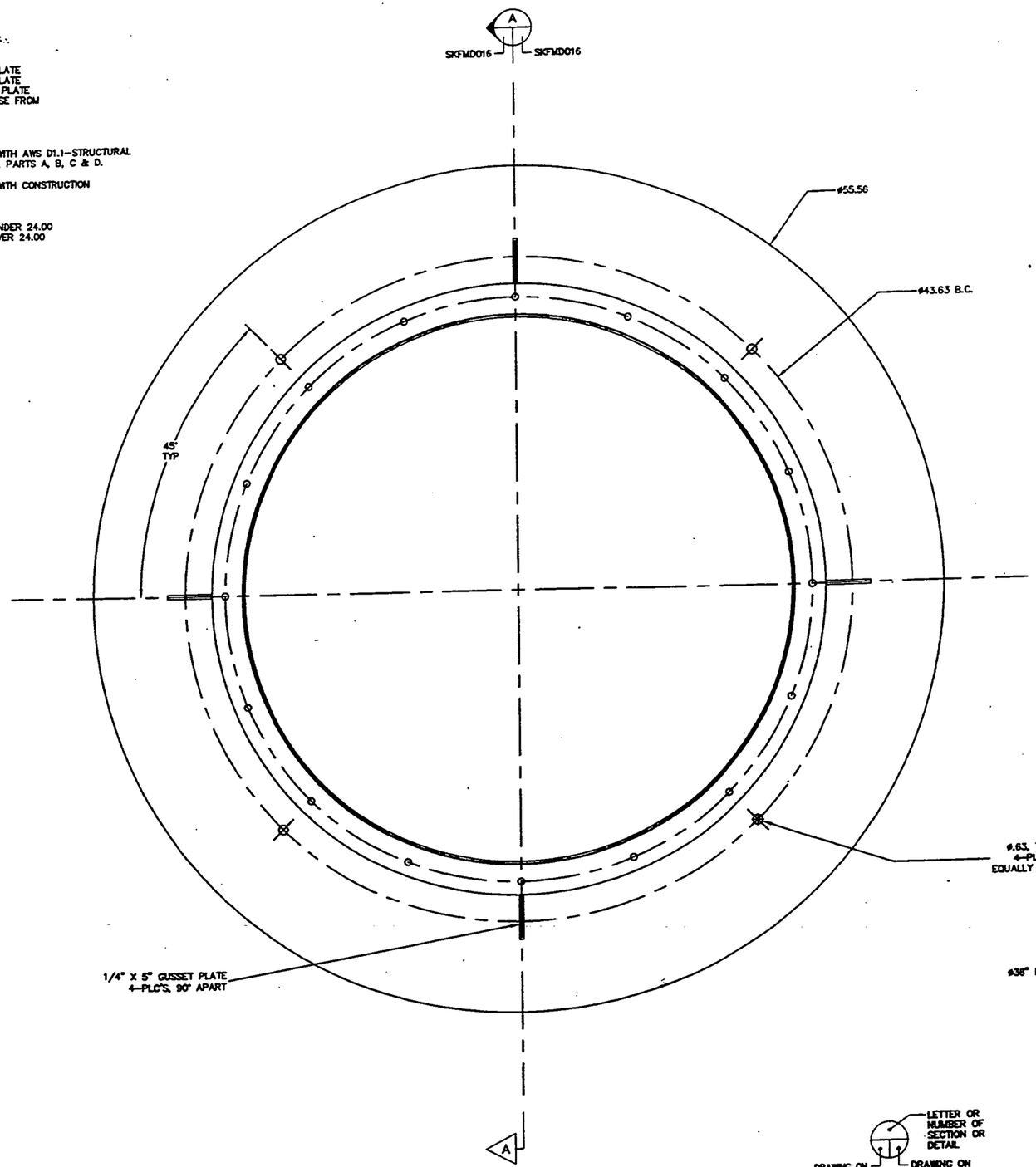
2) SHARP EDGES TO BE DEBURRED.

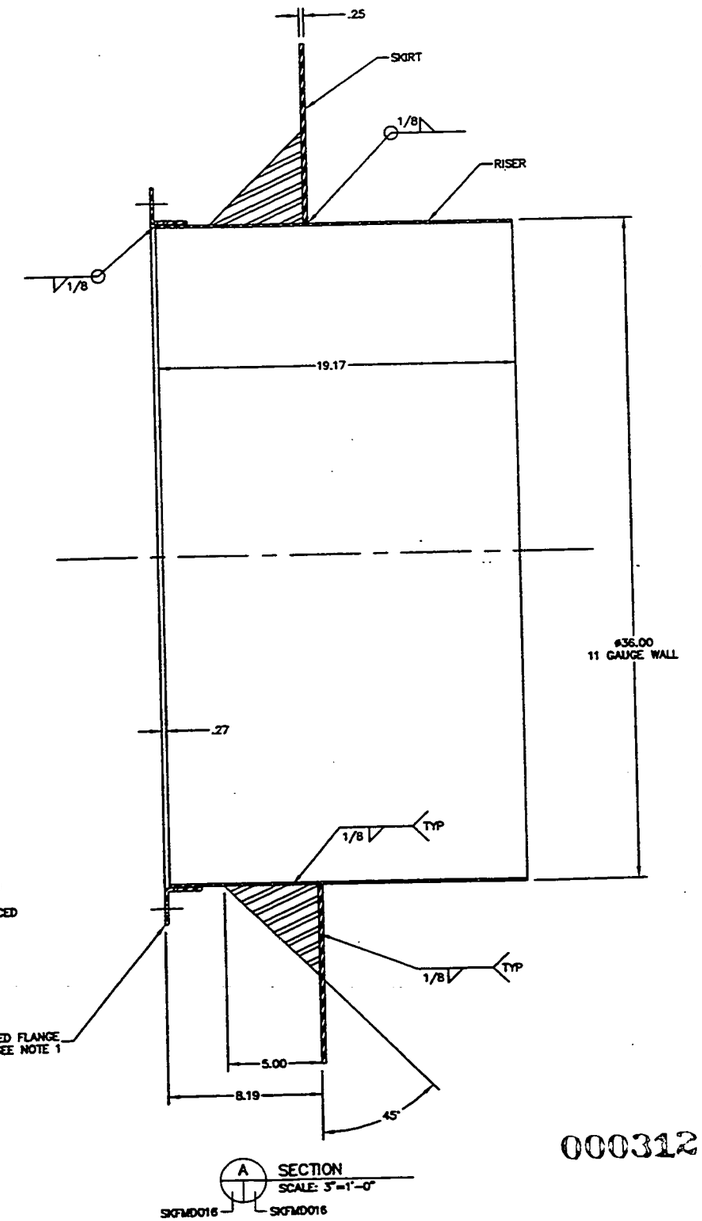
3) WELDING TO BE IN ACCORDANCE WITH AWS D1.1–STRUCTURAL WELDING CODE–STEEL, SECTION 5, PARTS A, B, C & D.

4) TO BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION DIVISION 09900.

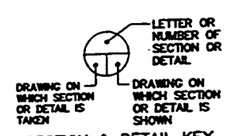
5) TOLERANCES:
X.XX ±0.05 FOR DIMENSIONS UNDER 24.00
X.XX ±0.10 FOR DIMENSIONS OVER 24.00
UNLESS OTHERWISE SPECIFIED.

6) ALL DIMENSIONS ARE IN INCHES.





000312



SECTION & DETAIL KEY

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 4 EMMA RISER SUBASSEMBLY		
SIZE D	SCALE: 3"=1'-0"	DWG. NO. SKFMD016

FILENAME: SKFMD016.DWG

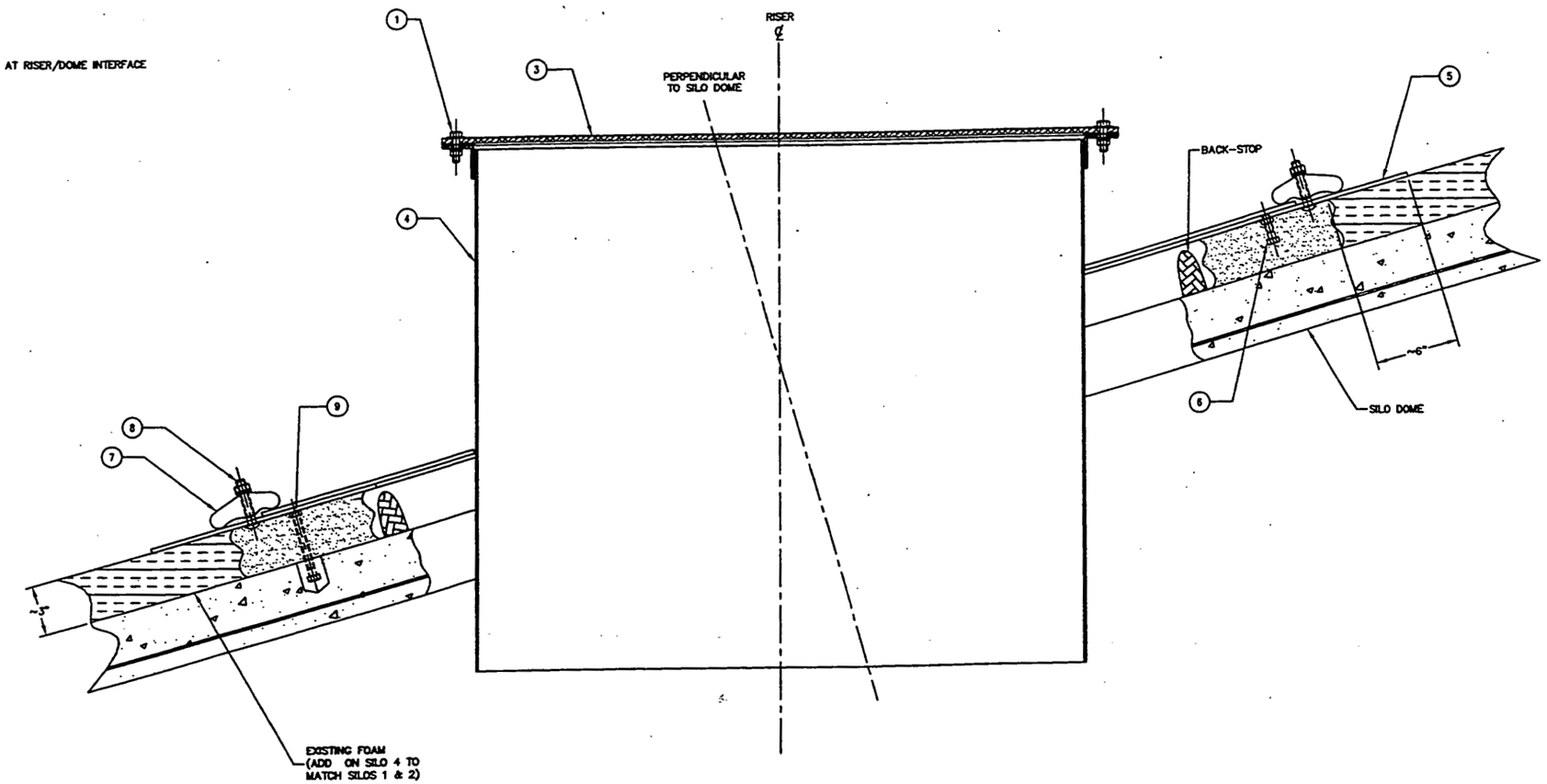
NOTES:

1. FOR RISER LOCATIONS SEE 10FMD017 & 11FMD019.
2. SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63.
3. INSTALLATION:
   - 3A) LOCATE CENTER OF PENETRATION
   - 3B) REMOVE MINIMUM #68" AREA OF EXISTING FOAM
   - 3C) ROUGHEN CONCRETE
   - 3D) MARK & DRILL 1"ø LOCATING BOLT HOLE ~2" DEEP INTO SILO DOME
   - 3E) APPLY BONDING AGENT
   - 3F) INSTALL BACK-STOP MATERIAL
   - 3G) PLACE GROUT BED
   - 3H) INSTALL BASE PLATE AROUND EXISTING RISER
   - 3I) ALLOW GROUT TO CURE
   - 3J) SECURE EXISTING RISER
   - 3K) CUT OUT EXISTING RISER THROUGH CENTER OF BASE PLATE, SEE DWG SKFMD006
   - 3L) APPLY SEALANT TO UNDERSIDE OF NEW RISER SKIRT
   - 3M) PLACE NEW RISER IN POSITION
   - 3N) INSTALL HEEL CLAMPS
   - 3O) CAULK ANY REMAINING AIR GAPS AT RISER/DOME INTERFACE

MATERIALS LIST

MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	16	BOLT, 7/16-14 UNC, 1.50" LONG	
2	1	NEOPRENE GASKET	
3	1	ALUMINUM COVER	DWG NO. SKFMD013
4	1	SLUICER RISER SUBASSEMBLY	DWG NO. SKFMD022
5	1	BASE PLATE	DWG NO. SKFMD005
6	3	ANCHOR BOLTS, 7/16-14 UNC, 1.50" LONG	
7	4	5" HEEL CLAMP	
8	4	CLAMP BOLT, 1/2-13 UNC, 2.75" LONG	
9	1	LOCATING BOLT, 7/16-14 UNC, 4.00" LONG	

3157



ELEVATION

000313

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE: SILO 1, 2 & 4 SLUICER RISER ASSEMBLY

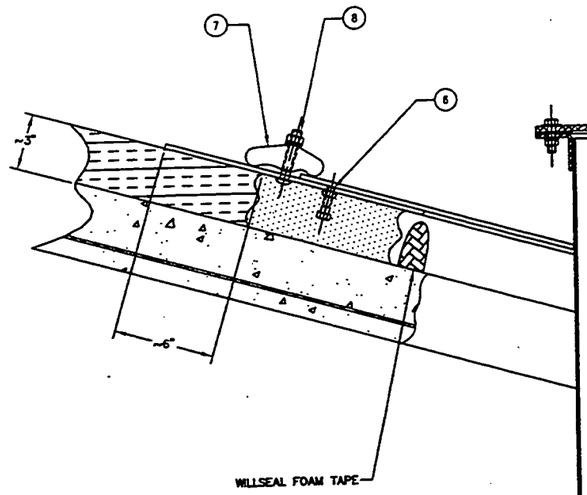
SIZE: D | SCALE: 3"=1'-0" | DWG. NO. SKFMD017

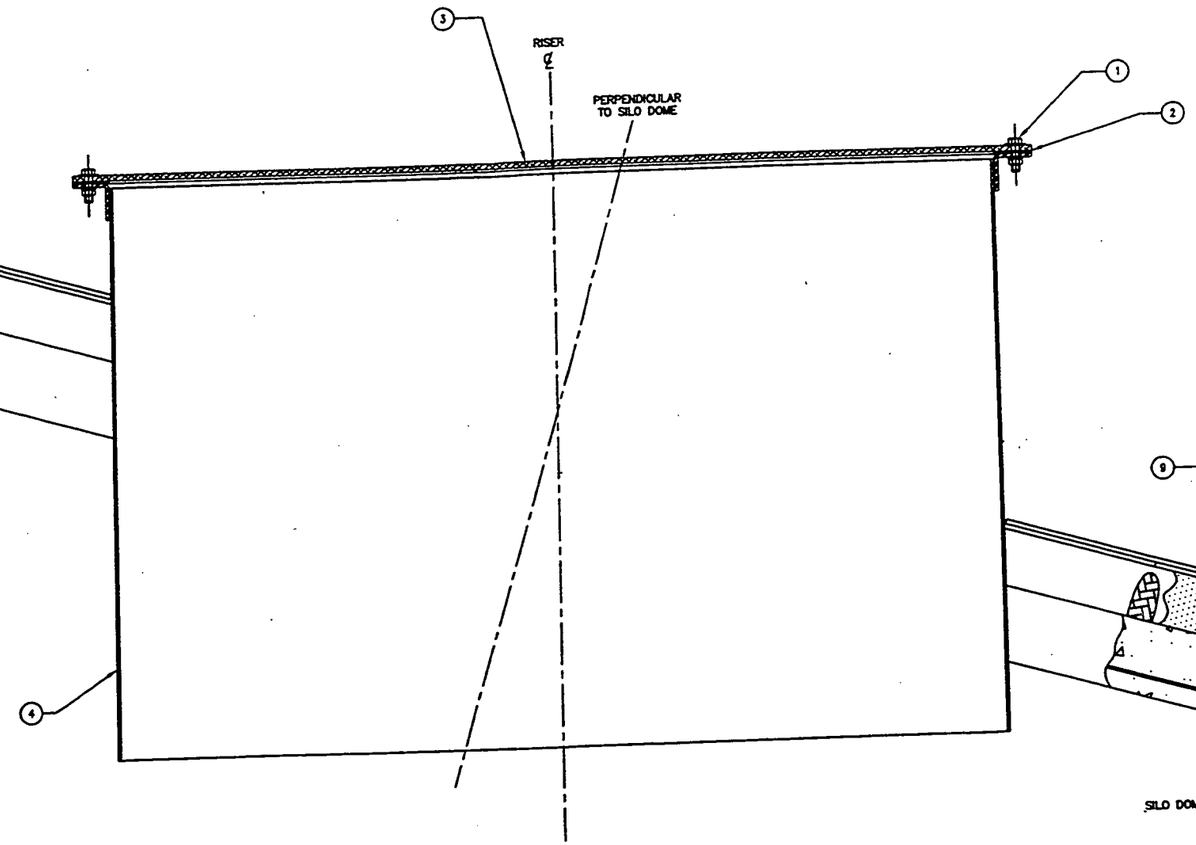
FILENAME: SKFMD017.DWG

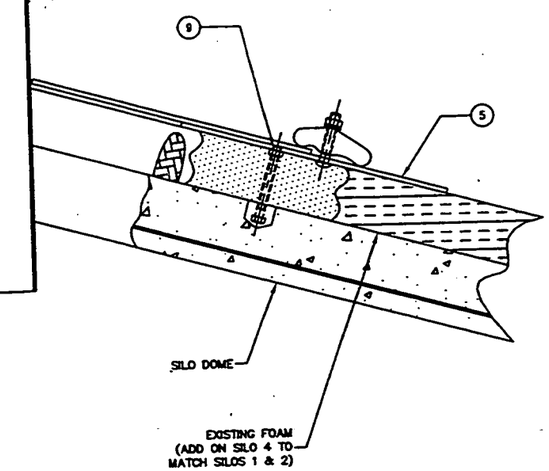
MATERIALS LIST

MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	24	BOLT, 7/16-14 UNC, 1.50" LONG	
2	1	NEOPRENE GASKET	
3	1	ALUMINUM COVER	DWG NO. SKFMD013
4	1	SLURRY RISER SUBASSEMBLY	DWG NO. SKFMD021
5	1	BASE PLATE	DWG NO. SKFMD005
6	3	ANCHOR BOLTS, 7/16-14 UNC, 1.50" LONG	
7	4	5" HEEL CLAMP	
8	4	CLAMP BOLT, 1/2-13 UNC, 2.75" LONG	
9	1	LOCATING BOLT, 7/16-14 UNC, 4.00" LONG	

3157







NOTES:

1. FOR RISER LOCATIONS SEE 10FMD017 & 11FMD019
2. SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63
3. INSTALLATION:
   - 3A) LOCATE CENTER OF PENETRATION
   - 3B) REMOVE MINIMUM ~86" AREA OF EXISTING FOAM
   - 3C) ROUGHEN CONCRETE
   - 3D) MARK & DRILL 1"ø LOCATING BOLT HOLE ~2" DEEP INTO SILO DOME
   - 3E) APPLY BONDING AGENT
   - 3F) INSTALL BACK-STOP MATERIAL
   - 3G) PLACE GROUT BED
   - 3H) INSTALL BASE PLATE AROUND EXISTING RISER
   - 3I) ALLOW GROUT TO CURE
   - 3J) SECURE EXISTING RISER
   - 3K) CUT OUT EXISTING RISER THROUGH CENTER OF BASE PLATE, SEE DWG SKFMD006
   - 3L) APPLY SEALANT TO UNDERSIDE OF NEW RISER SKIRT
   - 3M) PLACE NEW RISER IN POSITION
   - 3N) INSTALL HEEL CLAMPS
   - 3O) CAULK ANY REMAINING AIR GAPS AT RISER/DOME INTERFACE

000314

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE: SILO 1, 2 & 4 SLURRY RISER ASSEMBLY

SIZE	SCALE:	DWG. NO.
D	3"=1'-0"	SKFMD018

FILENAME: SKFMD018.DWG

NOTES:

1. FOR RISER LOCATIONS SEE 11FMD019
2. SEE "SILO PENETRATION AND RISER INSTALLATION", 624-P622-63
3. INSTALLATION:
   - 3A) REMOVE MINIMUM ø50" AREA OF EXISTING FOAM
   - 3B) REMOVE PLYWOOD FROM ø4' INNER CHORD OF STRUCTURE
   - 3C) CUT OUT BRACE RUNNING THROUGH CENTER OF INNER CHORD
   - 3D) USING TEMPLATE, DRILL AND TAP 4 ø1/2"-13 UNC HOLES FOR SECURING RISER.
   - 3E) DRILL ANCHOR ROPE HOLES THRU SILO DOME
   - 3F) SECURE ANCHOR ROPES
   - 3G) CUT ~ø39" PENETRATION THRU DOME
   - 3H) REMOVE CONCRETE CUTOUTS.
   - 3I) APPLY SEALANT TO UNSIDE OF NEW RISER SKIRT
   - 3J) PLACE NEW RISER IN POSITION
   - 3K) APPLY THREAD SEALANT TO 1/2-13 BOLTS AND SECURE NEW RISER TO BENT STEEL PLATE
   - 3L) CAULK ANY REMAINING AIR GAPS AT RISER/COVER INTERFACE
   - 3M) INSTALL NEW POLYURETHANE FOAM

MATERIALS LIST

MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	16	BOLT, 7/16-14 UNC, 1.50" LONG	
2	1	NEOPRENE GASKET	
3	1	ALUMINUM COVER	DWG NO. SKFMD013
4	1	EMMA RISER SUBASSEMBLY	DWG NO. SKFMD020
5	4	BOLT, 1/2-13 UNC, 1.00" LONG	

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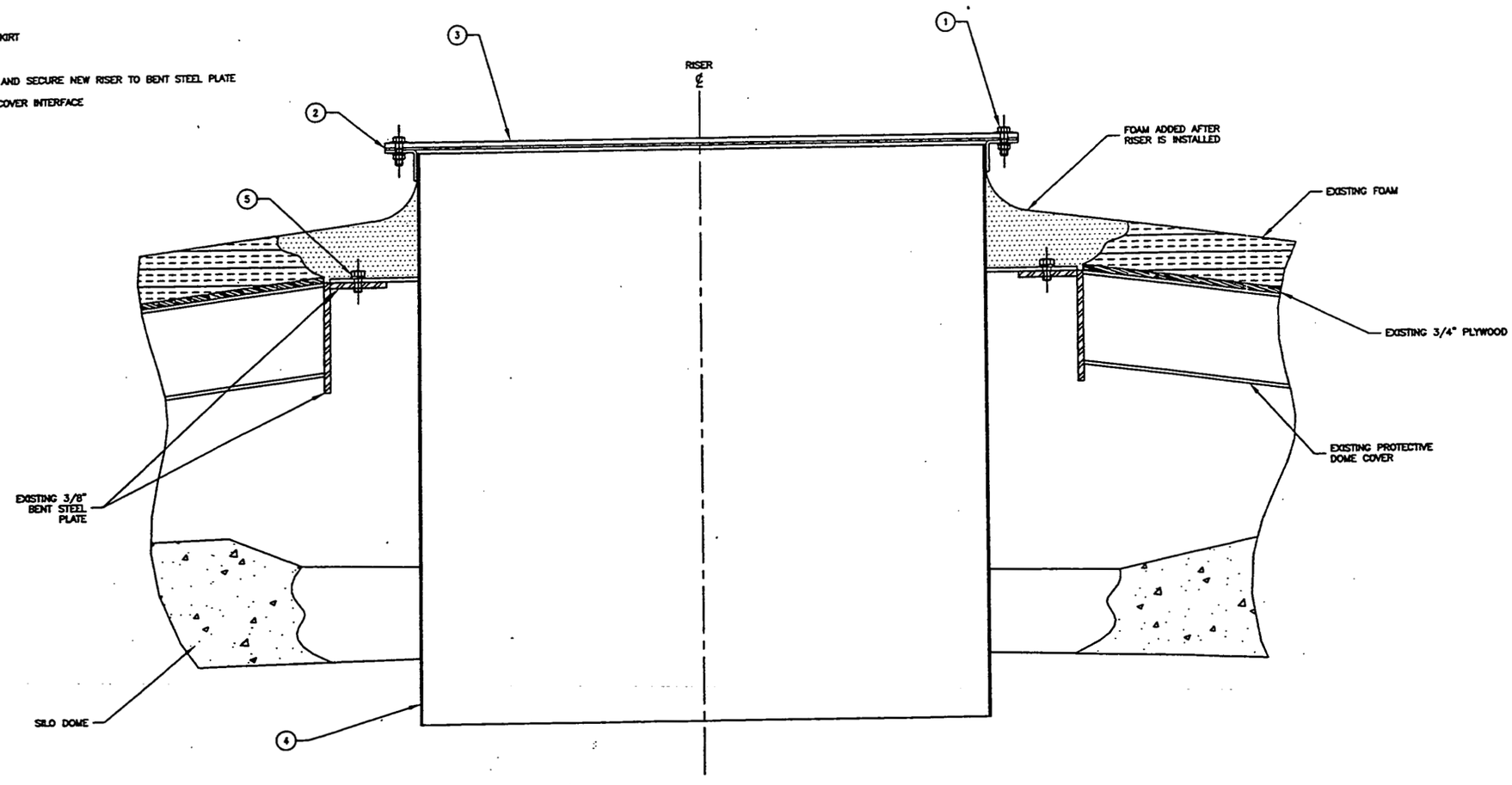


ELEVATION

000315

PRELIMINARY
NOT FOR CONSTRUCTION

TITLE		
SILO 1 & 2 EMMA RISER ASSEMBLY		
SIZE D	SCALE: 3"=1'-0"	DWG. NO. SKFMD019

FILENAME: SKFMD019.DWG

Appendix A

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05

INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
10FMD002	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM RADON CONTROL SYSTEM	2
10FMD003	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM RADON CONTROL SYSTEM	2
10FMD007	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM SILO 4 - SWRS MODE	2
10FMD008	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM SLURRY & WATER PIPING TIE-IN	2
10FMD009	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM PHASE SEPARATORS	2
10FMD010	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM HP PUMP SKID SKD-11-250	2
10FMD011	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM SILO 4 – CATS MODE	2
11FMD003	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM SILO 2 – SWRS MODE	2

000316

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05 INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
11FMD004	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM DIVERTER BOX ENC-11-001	2
11FMD005	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM SLURRY LINE CLEANOUTS	2
11FMD006	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM HP PUMP SKID SKD-11-251	2
11FMD007	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM SAMPLE VALVE ENCLOSURE	2
11FMD008	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM SAMPLE SYSTEM	2
11FMD009	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM SILO 1 – CATS MODE	2
12FMD001	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM DISTRIBUTION ENC-12-001	2
12FMD002	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-001A	2

000317

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05 INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
12FMD003	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-001B	2
12FMD004	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-002A	2
12FMD005	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-002B	2
12FMD006	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM BUILDING SUMP SMP-12-003	2
12FMD007	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM ULTRA FILTRATION SKD-12-001	2
12FMD008	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM FILTRATE SYSTEM	2
12FMD018	TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM FILTRATE RECIRC & TRANSFER	A
13FMD002	TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM STORAGE TANK	2

000318

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05 INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
13FMD003	TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM SAMPLE VALVE ENCLOSURE	2
13FMD004	TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM FUTURE REMEDIATION FACILITY	2
14FMD002	DECANT SUMP RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM DECANT SUMP RETRIEVAL	2
20FMD003	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM SILO 2	2
20FMD004	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM SILO 1	3
20FMD005	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM FILTER & FILTRATE STORAGE TANKS	2
20FMD006	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM TTA STORAGE TANKS	2
20FMD007	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM CARBON BEDS	2

000319

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05 INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
20FMD008	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM AIR HANDLING & CONDENSATE	2
20FMD009	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM SAMPLE TANKS	2
20FMD010	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM EXHAUST & RECIRC FAN	2
20FMD011	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM DECANT WASTE RETRIEVAL	1
51FMD001	POTABLE/DOMESTIC WATER SYS PROCESS FLOW DIAGRAM MAKE-UP WATER	2
77FMD001	MISC FACILITIES HVAC SYSTEM HVAC FLOW DIAGRAM LOCATION AND CONTROL	C
77FMD003	MISC FACILITIES HVAC SYSTEM HVAC FLOW DIAGRAM RCS BLDG VENTILATION 1ST FLOOR	C
77FMD004	MISC FACILITIES HVAC SYSTEM HVAC FLOW DIAGRAM SAMPLE BLDG VENTILATION	C

000320

Process Flow Diagrams for All Systems

DOCUMENT NO. 624-P622-05 INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
77FMD005	MISC FACILITIES HVAC SYSTEM HVAC FLOW DIAGRAM RCS BLDG VENTILATION 2ND FLOOR	C
77FMD006	MISC FACILITIES HVAC SYSTEM HVAC CONTROL DIAGRAM RCS BLDG VENTILATION 1ST FLOOR	B
77FMD007	MISC FACILITIES HVAC SYSTEM HVAC CONTROL DIAGRAM SAMPLE BLDG VENTILATON	B
77FMD008	MISC FACILITIES HVAC SYSTEM HVAC CONTROL DIAGRAM RCS BLDG VENTILATION 2ND FLOOR	B

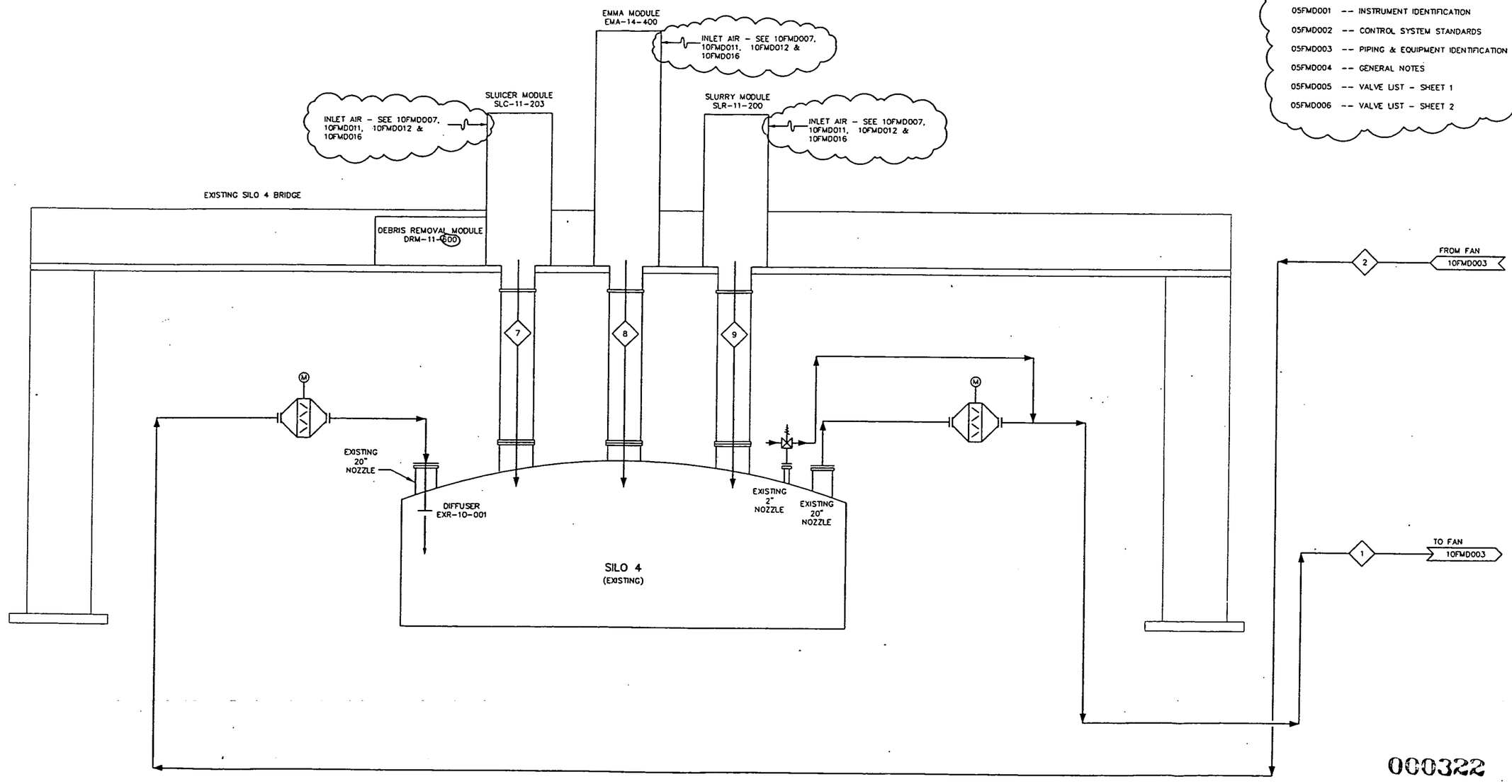
INFORMATION ONLY

NOTES: - 3157

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD001.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000322

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
RADON CONTROL SYSTEM

SIZE	SCALE:	DWG. NO.	REV
D	NONE	10FMD002	2

FILENAME: 10FMD002.DWG

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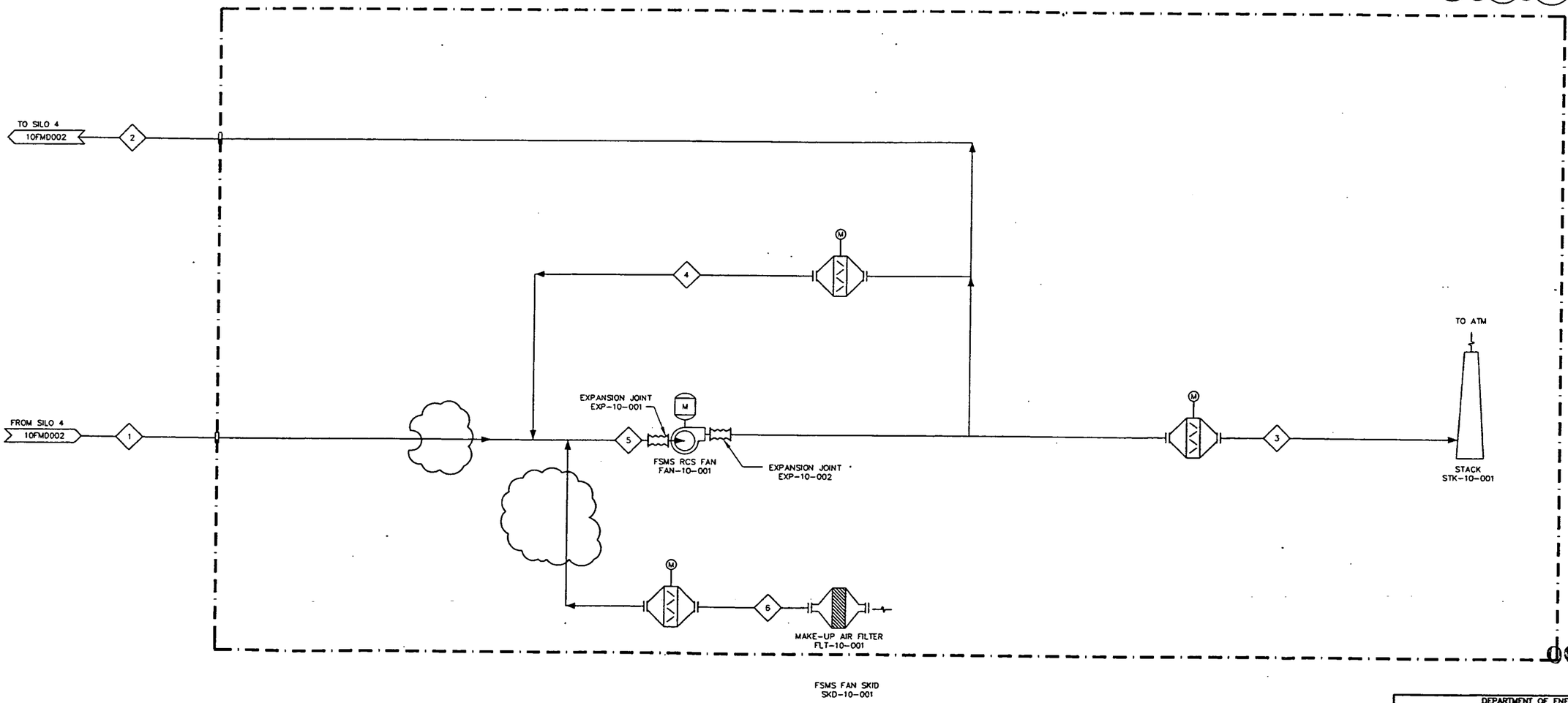
INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD001.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



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THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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0	01/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY	B J DAVIS	DATE 01/07/00
DESIGNED BY	B J DAVIS	DATE 01/07/00
CHECKED BY	S W HUNGATE	DATE 01/07/00
APPROVED BY	KENNETH RICKETT	DATE 01/07/00
APPROVED BY	JOHN LAWSON	DATE 01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
RADON CONTROL SYSTEM

SIZE	SCALE	DWG. NO.	REV
D	NONE	10FMD003	2

FILENAME: 10FMD003.DWG

J-3157

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INFORMATION ONLY

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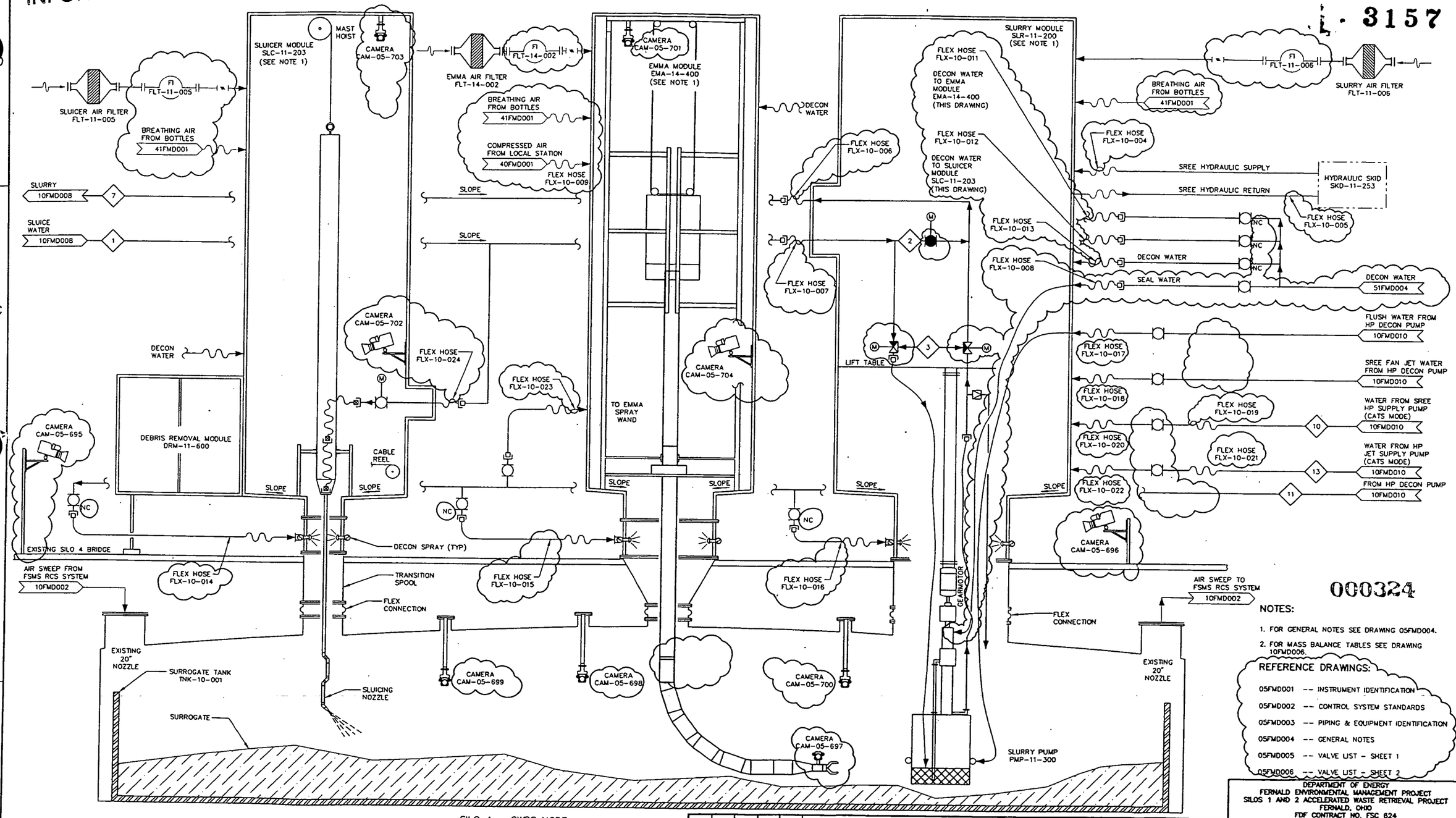

SILO 4 – SWRS MODE

000324

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD006.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST – SHEET 1
05FMD006 -- VALVE LIST – SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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APPROVED BY	J LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
SILO 4 – SWRS MODE

SIZE	SCALE	DWG. NO.	REV
D	NONE	10FMD007	2

FILENAME: 10FMD007.DWG

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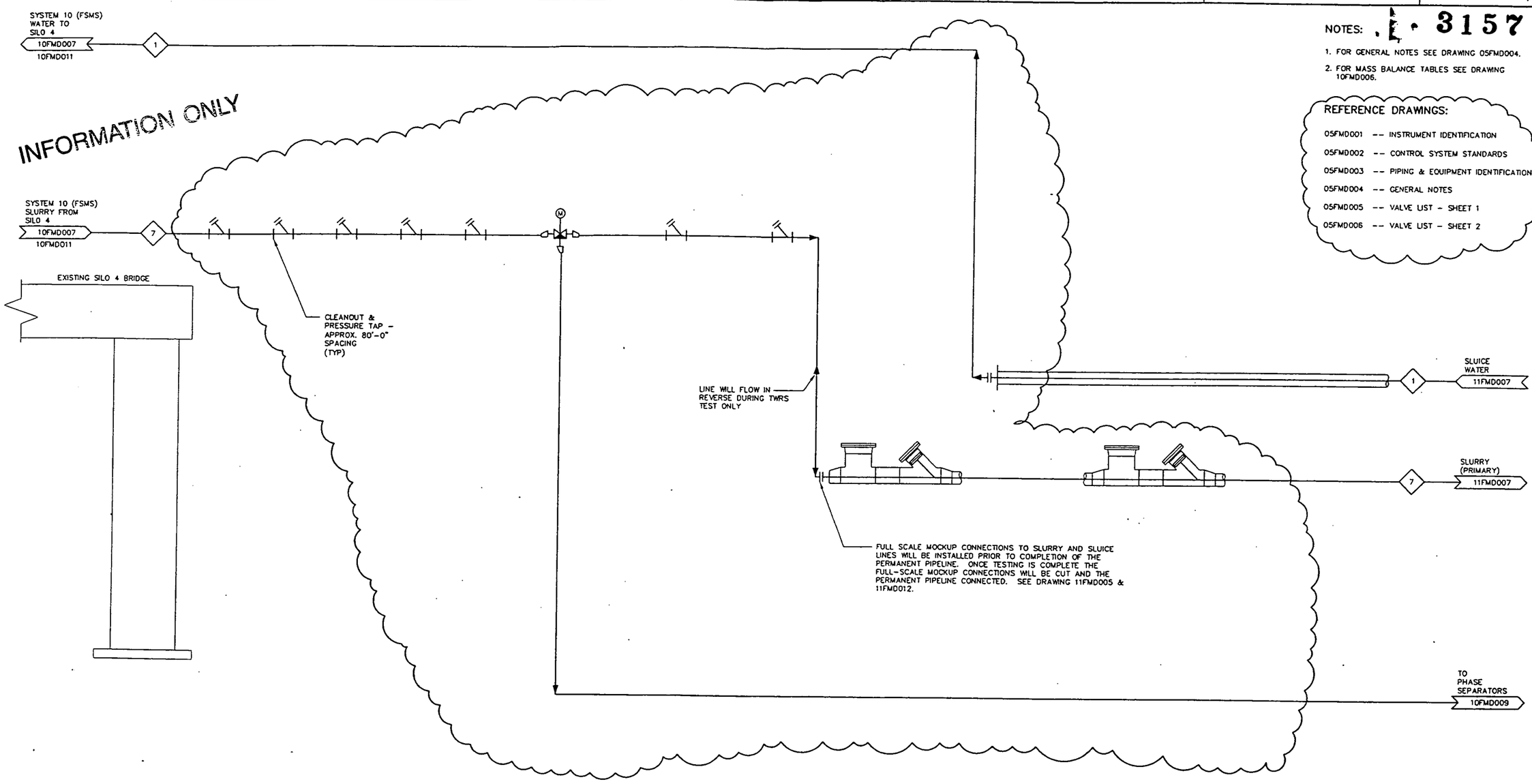

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD006.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

3157

000325

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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PE

DRAWN BY	B J DAVIS	DATE 01/07/00
DESIGNED BY	B J DAVIS	DATE 01/07/00
CHECKED BY	S W HUNGATE	DATE 01/07/00
APPROVED BY	KENNETH RICKETT	DATE 01/07/00
APPROVED BY	JOHN LAWSON	DATE 01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
SLURRY & WATER PIPING TIE-IN

SIZE	SCALE	DWG. NO.	REV
D	NONE	10FMD008	2

FILENAME: 10FMD008.DWG

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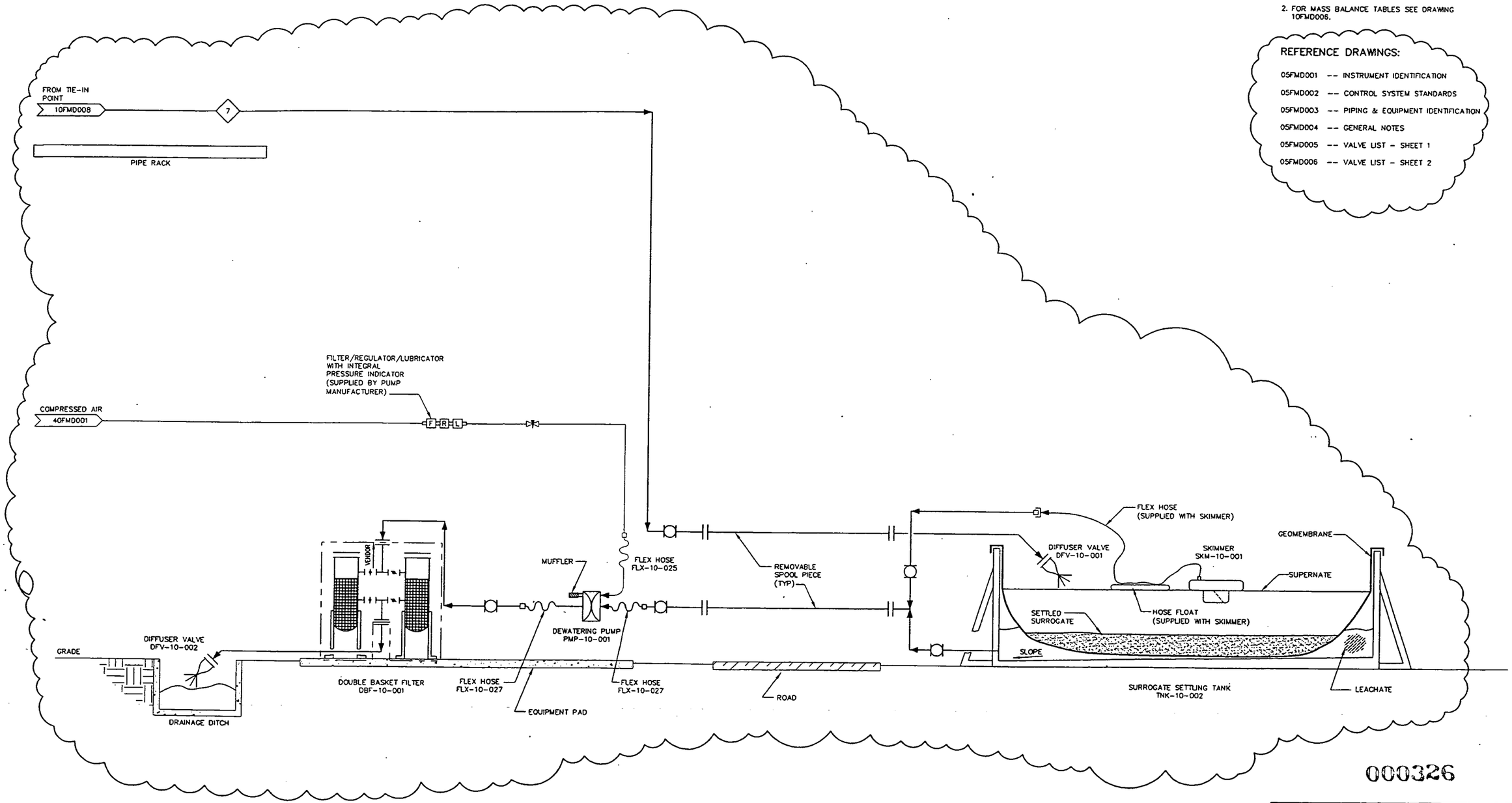
INFORMATION ONLY

NOTES: L-3157

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD006.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



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THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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0	01/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
SURROGATE DEWATERING

SIZE	SCALE:	DWG. NO.	REV
D	NONE	10FMD009	2

FILENAME: 10FMD009.DWG

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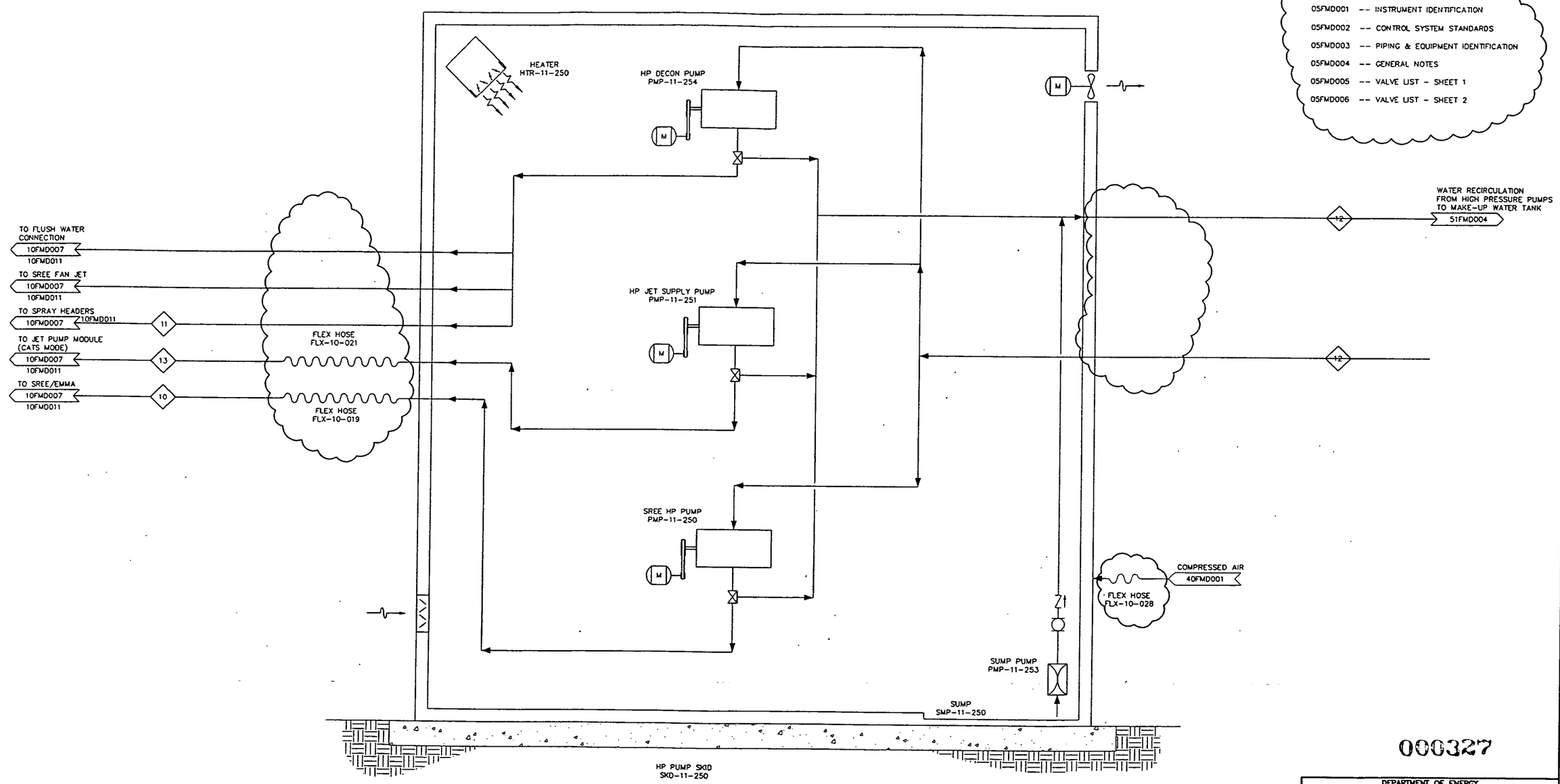
INFORMATION ONLY

NOTES: 3157

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD006.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000327

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	01/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
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APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

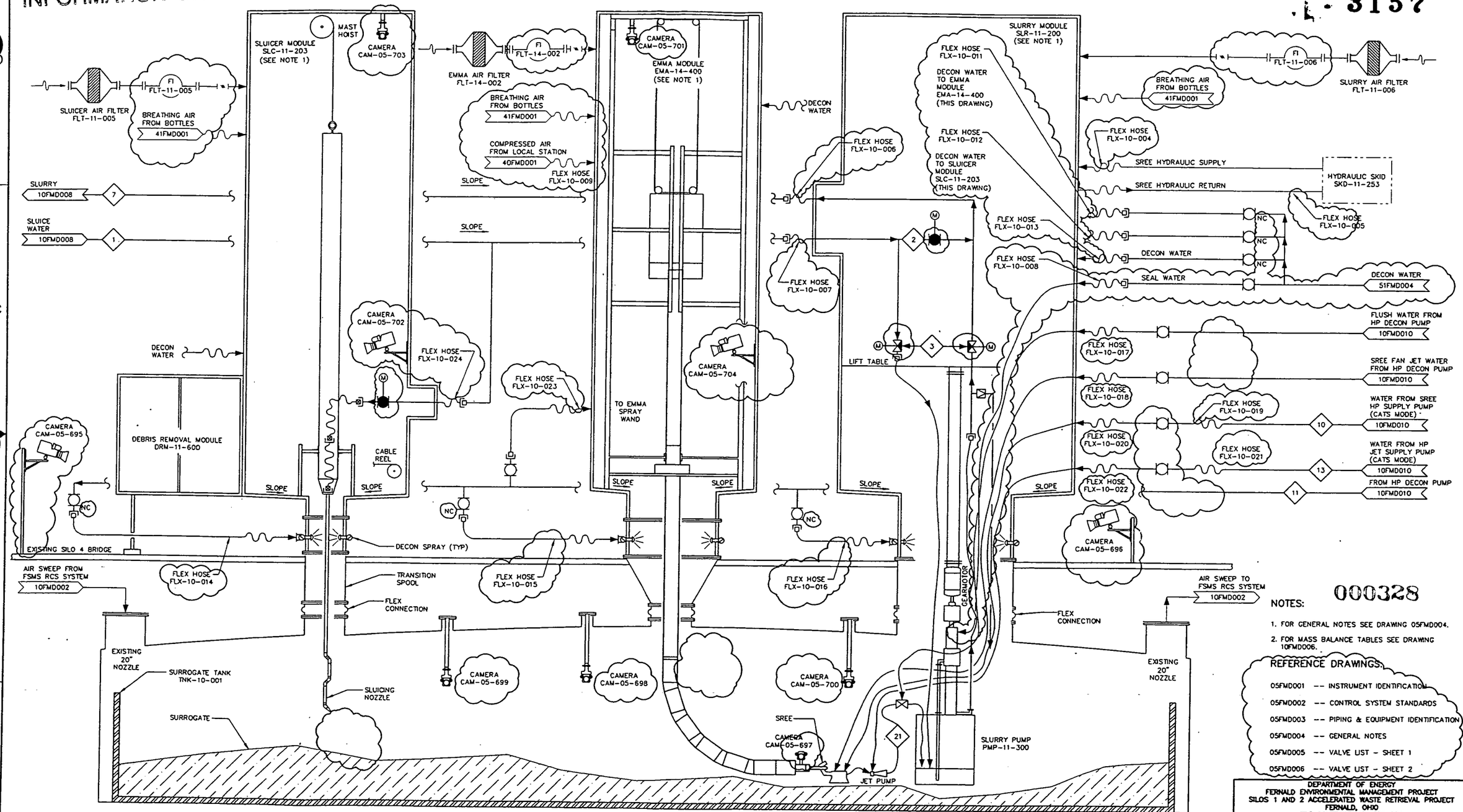
TITLE
FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
HP PUMP SKID SKD-11-250

SIZE D | SCALE: NONE | DWG. NO. 10FMD010 | REV 2

FILENAME: 10FMD010.DWG

INFORMATION ONLY

L-3157



SILO 4 – CATS MODE

000328

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 10FMD006.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST – SHEET 1
05FMD006 -- VALVE LIST – SHEET 2

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE

FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM SILO 4 – CATS MODE

SIZE	SCALE:	DWG. NO.	REV
D	NONE	10FMD011	2

FILENAME: 10FMD011.DWG

JOB NAME: 10FMD011.DWG, 05/26/2000 02:35:33 PM

FORMATION ONLY

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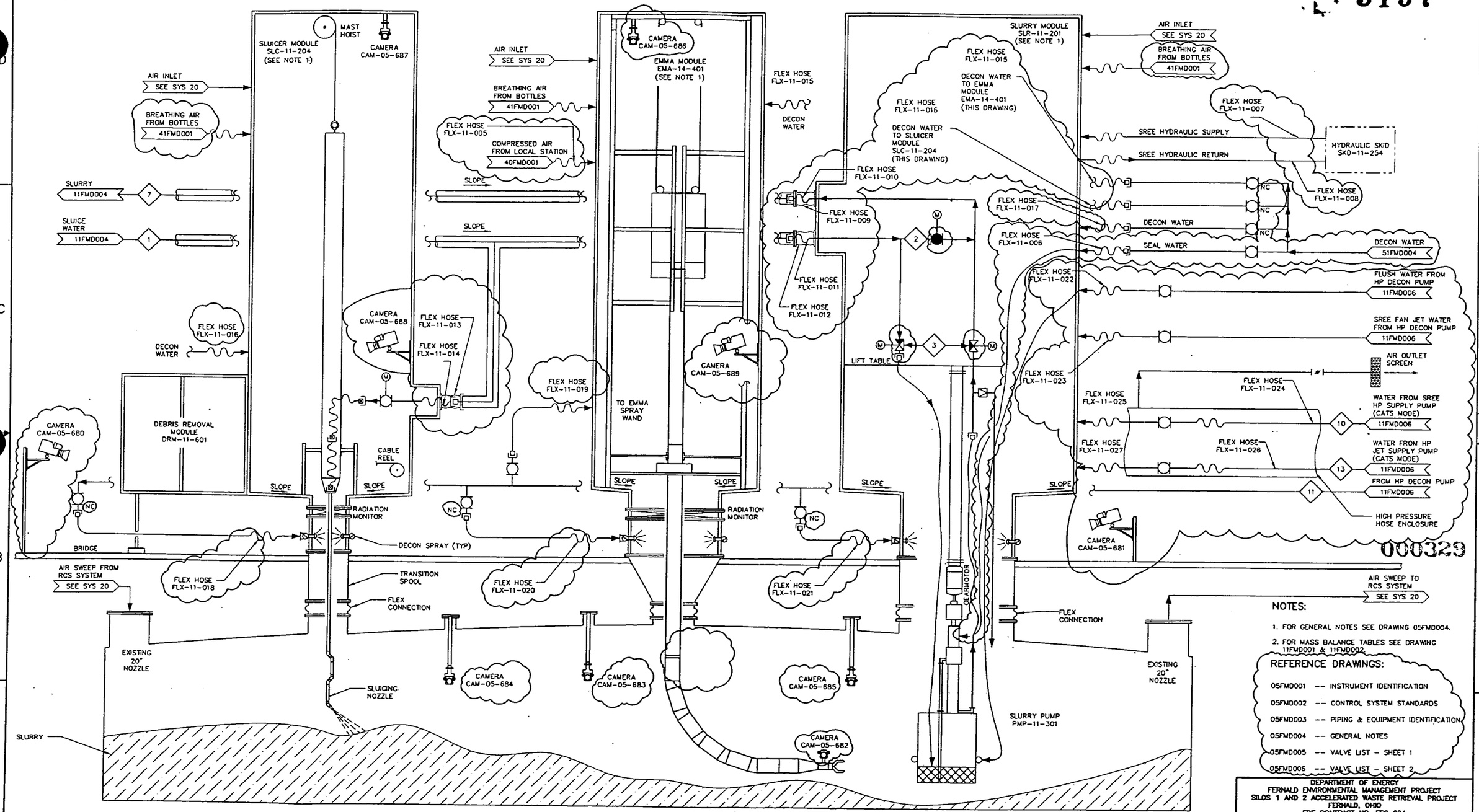

SILO 2 – SWRS MODE

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST – SHEET 1
05FMD006 -- VALVE LIST – SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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1	01/01/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
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RPE

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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
SILO 2 – SWRS MODE

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD003	2

FILENAME: 11FMD003.DWG

11VAR/UGF/EUDAS/UIL/FMD/UEL/FDF/SILOS/PEC/S/TS11111fmd003.dwg, 05/26/2000 02:39:03 PM

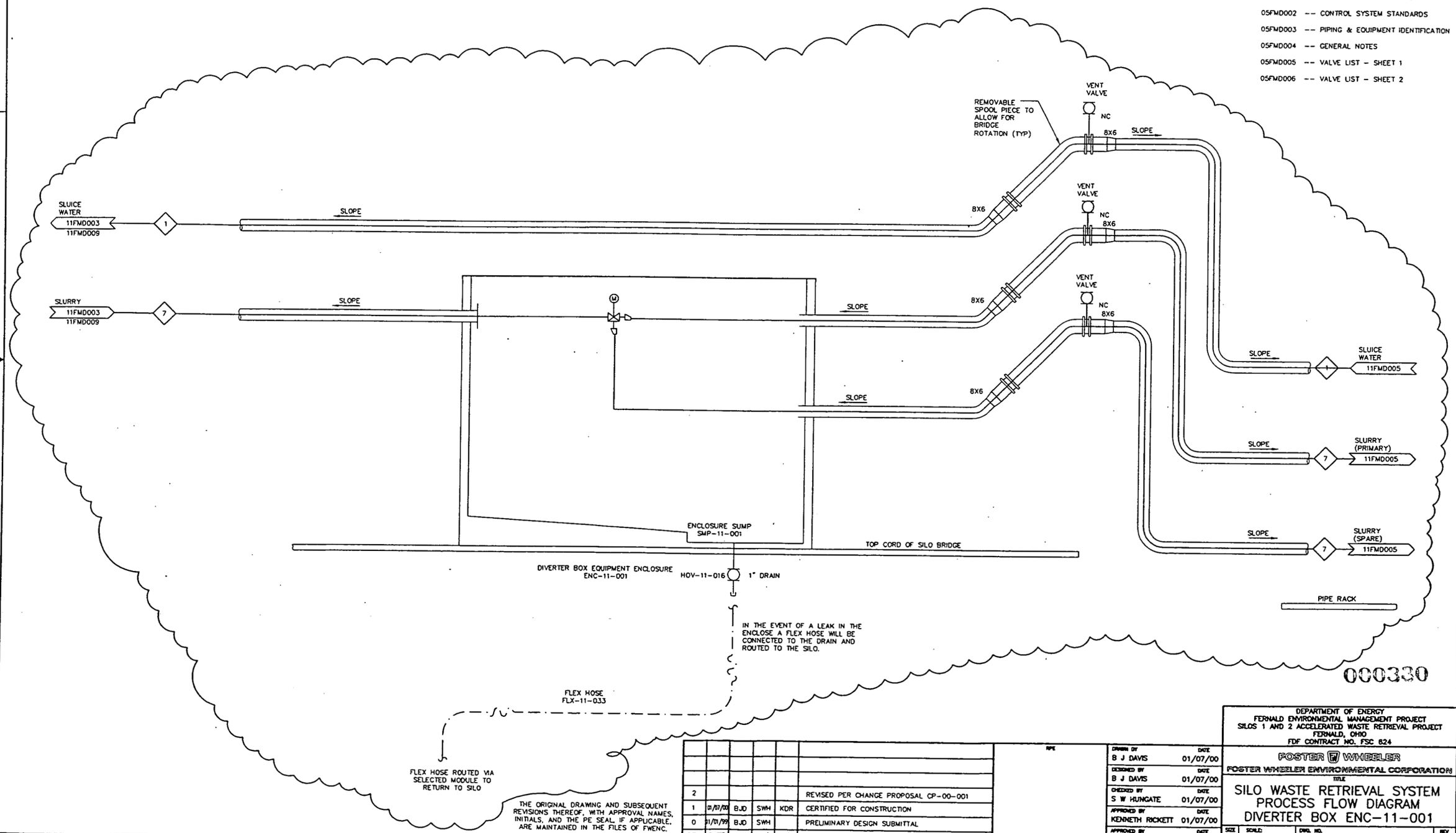
INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000330

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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CHECKED BY	S W HUNGATE	01/07/00
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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
DIVERTER BOX ENC-11-001

SIZE	SCALE	DWG. NO.	REV
D	NONE	11FMD004	2

FILENAME: 11FMD004.DWG

.ogle\eoascoll.HARKLE\FDFSILOS\MECL\SYS11\11fmd004.dwg, 05/26/2000 02:39:31 PM

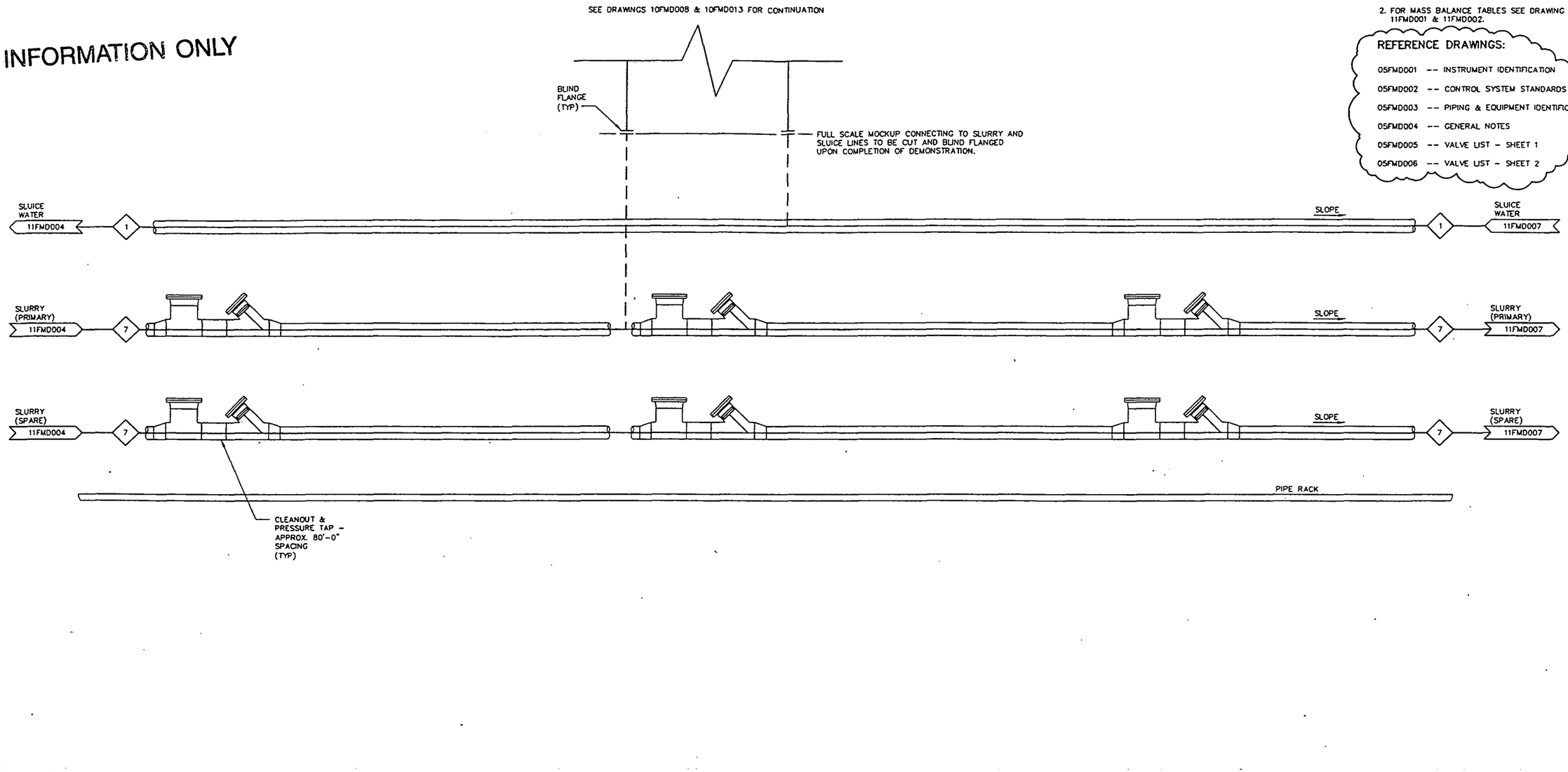
INFORMATION ONLY

NOTES: L - 3157

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000331

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
SLURRY LINE CLEANOUTS

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD005	2

FILENAME: 11FMD005.DWG

3157

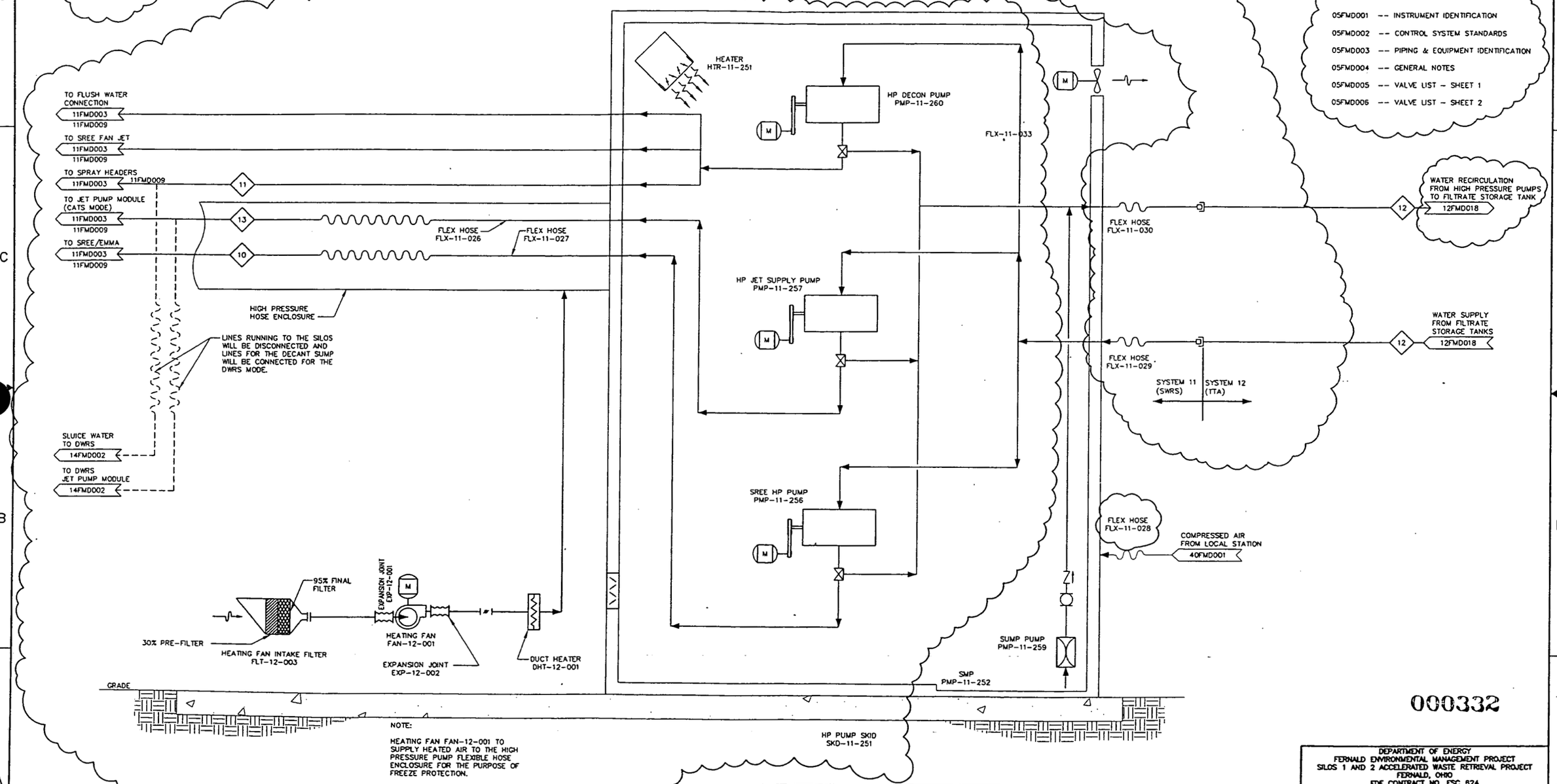
INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000332

NOTE:

HEATING FAN FAN-12-001 TO SUPPLY HEATED AIR TO THE HIGH PRESSURE PUMP FLEXIBLE HOSE ENCLOSURE FOR THE PURPOSE OF FREEZE PROTECTION.

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
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0	01/07/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
HP PUMP SKID SKD-11-251

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD006	2

FILENAME: 11FMD006.DWG

INFORMATION ONLY

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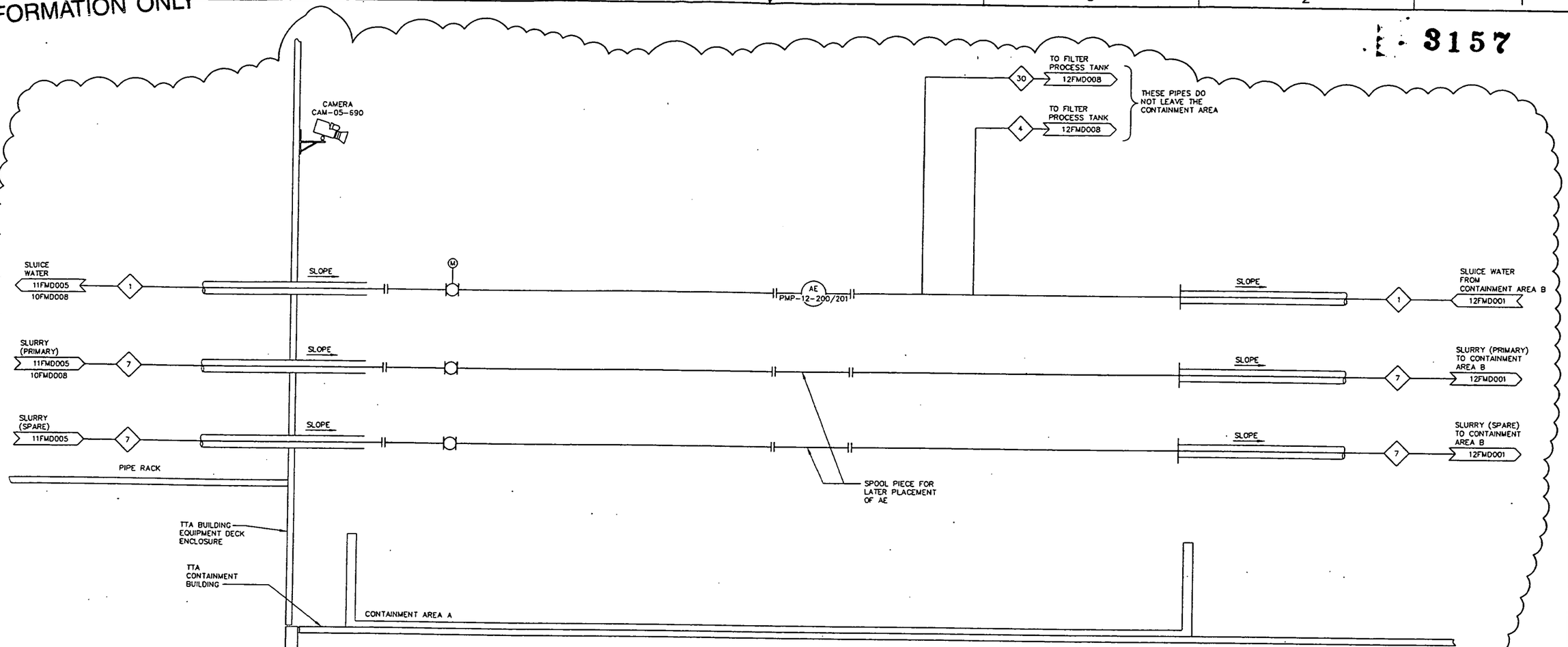

000333

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
PROCESS ANALYZER

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD007	2

FILENAME: 11FMD007.DWG

INFORMATION ONLY

3157

VOID

SLURRY FROM SAMPLE VALVES 11FMD007

SLOPE

CAMERA CAM-05-011

COMPRESSED AIR 40FMD001

COMPRESSED AIR 40FMD001

SELF C... ...ATER

SAMPLE BUILDING

DECANT PUMP PMP-11-004

DECANT LIQUID AND SOLIDS TO TTA 11FMD007

SLOPE

VENT TO RCS SEE SYS 20

VENT TO RCS SEE SYS 20

SAMPLE TANK TNK-11-001A 185 GAL

...MPLE TANK ...K-11-001B 185 GAL

2 TON BRIDGE CRANE CRH-11-001

CAMERA CAM-05-010

SLIDE GATE SLG-11-001

VOLUMETRIC FEEDER SCM-11-001A

SLIDE GATE SLG-11-003

VOLUMETRIC FEED... SCM-11-001B

VENT TO RCS SEE SYS 20

SLIDE GATE SLG-11-002

SLIDE GATE SLG-11-004

FLEXIBLE BOOT FLX-11-005

FLEXIBLE FLX...

EMPTY 30 GALLON DRUM INSIDE 55 GALLON OVERPACK

SUMP PUMP PMP-11-003

CONTAINMENT CURB (TYP)

STORAGE AREA

WORK ...ATION

DRUM FILLING STATION

CONVEYOR SSS-11-001

LIFT TABLE

DRUM FILLING STATION

SAMPLE BUILDING SUMP SMP-11-003

SAMPLE SYSTEM

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 PIPING & INSTRUMENT DIAGRAM – INSTRUMENT IDENTIFICATION

05FMD002 PIPING & INSTRUMENT DIAGRAM – CONTROL SYSTEM STANDARDS

05FMD003 PIPING & INSTRUMENT DIAGRAM – PIPING & EQUIPMENT IDENTIFICATION

000334

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					DRAWING VOIDED
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
SAMPLE SYSTEM

SIZE D | SCALE: NONE | DWG. NO. 11FMD008 | REV 2

FILENAME: 11FMD008.DWG

Wed 5:14:20 01/26/2000 0:/pdf/11fmd008.dwg

INFORMATION ONLY

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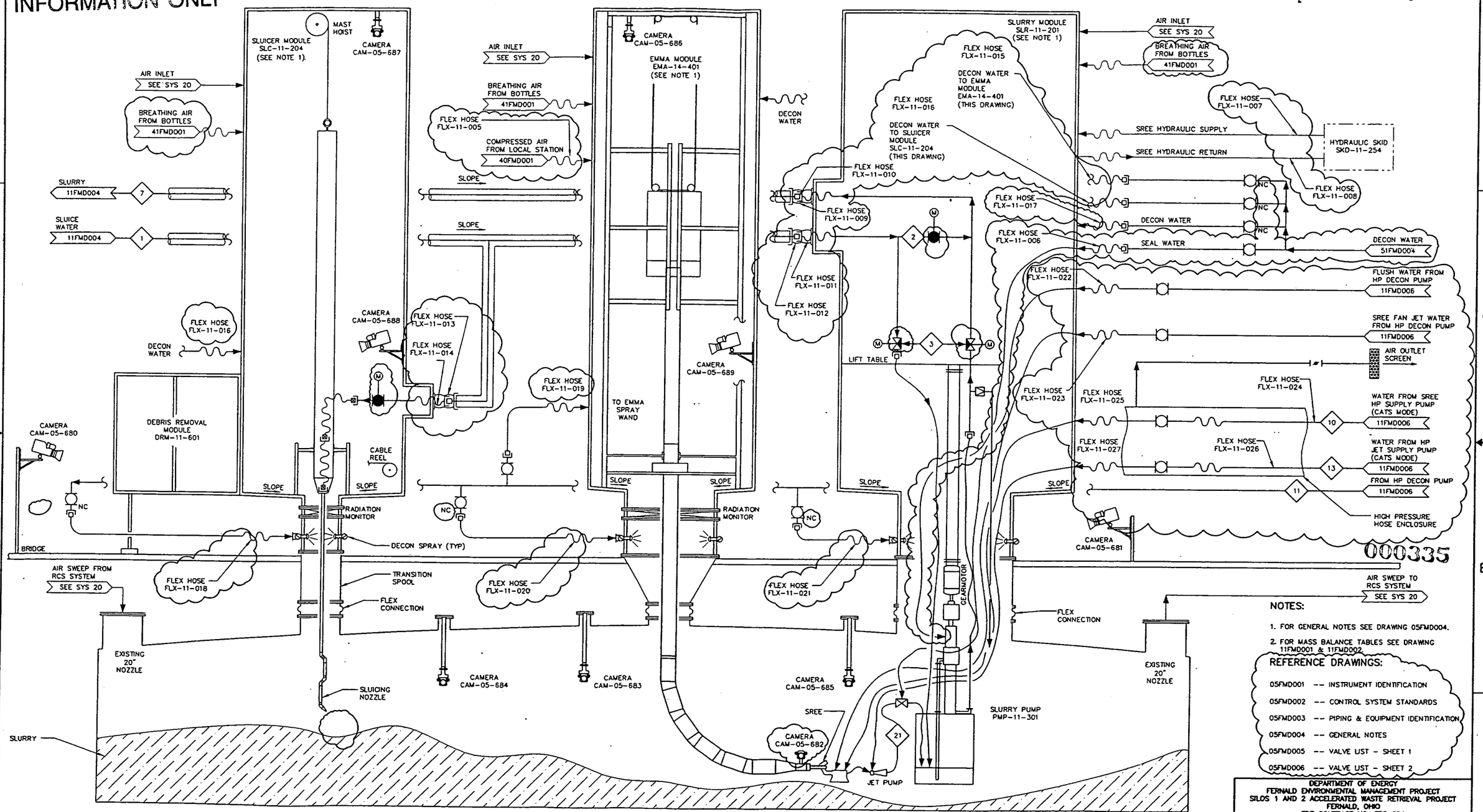

SILO 1 – CATS MODE

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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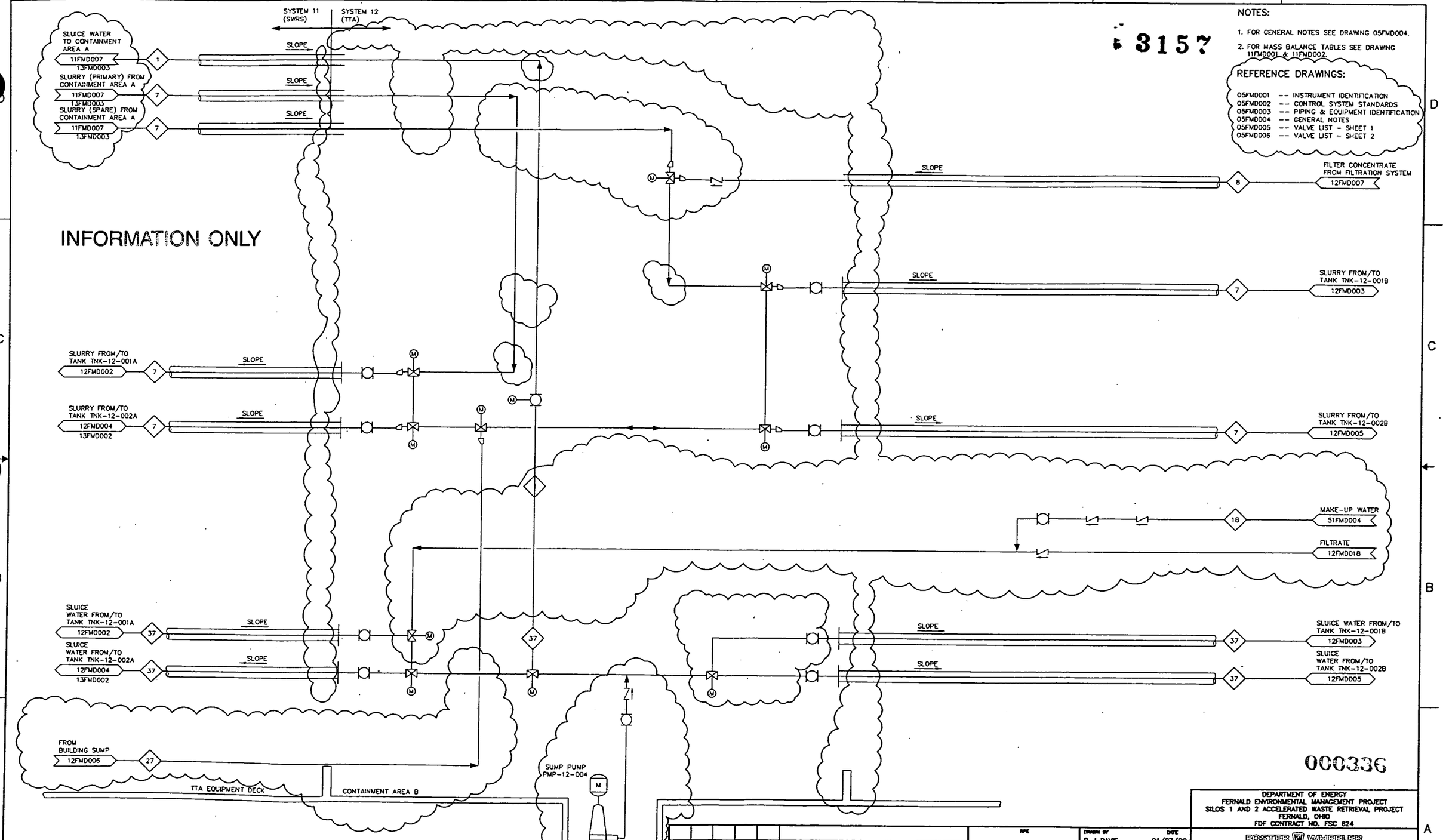
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
SILO 1 – CATS MODE

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD009	2

FILENAME: 11FMD009.DWG



INFORMATION ONLY

3157

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

000336

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
(CONTAINMENT AREA B)

SIZE: D | SCALE: NONE | DWG. NO. 12FMD001 | REV 2

FILENAME: 12FMD001.DWG

INFORMATION ONLY

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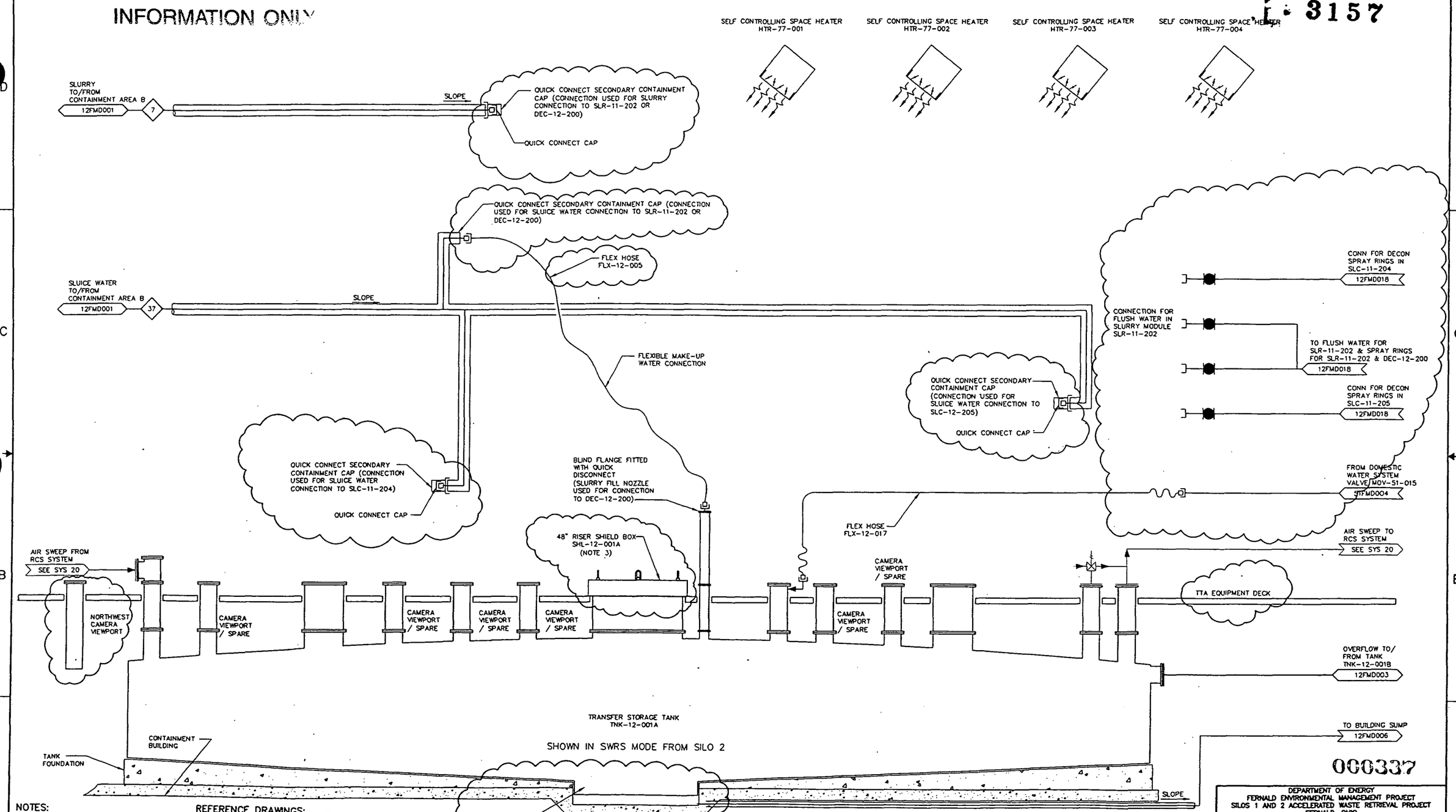

000337

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.
3. SHIELD BOX TO BE PLACED OVER E2-48" RISER WHEN NOT IN USE.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
STORAGE TANK TNK-12-001A

SIZE	SCALE	DWG. NO.	REV
D	NONE	12FMD002	2

FILENAME: 12FMD002.DWG

INFORMATION ONLY

SELF CONTROLLING SPACE HEATER HTR-77-005

SELF CONTROLLING SPACE HEATER HTR-77-006

SELF CONTROLLING SPACE HEATER HTR-77-007

SELF CONTROLLING SPACE HEATER HTR-77-008

SLURRY TO/FROM CONTAINMENT AREA B
12FMD001 7

SLOPE

QUICK CONNECT SECONDARY CONTAINMENT CAP (CONNECTION USED FOR SLURRY CONNECTION TO SLR-11-202 OR DEC-12-201)

QUICK CONNECT CAP

QUICK CONNECT SECONDARY CONTAINMENT CAP (CONNECTION USED FOR SLUICE WATER CONNECTION TO SLR-11-202 OR DEC-12-201)

FLEX HOSE FLX-12-010

SLUICE WATER TO/FROM CONTAINMENT AREA B
12FMD001 37

SLOPE

FLEXIBLE MAKE-UP WATER CONNECTION

QUICK CONNECT SECONDARY CONTAINMENT CAP (CONNECTION USED FOR SLUICE WATER CONNECTION TO SLC-12-205)

QUICK CONNECT CAP

QUICK CONNECT SECONDARY CONTAINMENT CAP (CONNECTION USED FOR SLUICE WATER CONNECTION TO SLC-11-204)

QUICK CONNECT CAP

48" RISER SHIELD BOX SHL-12-001B (NOTE 3)

FLEX HOSE FLX-12-017

AIR SWEEP FROM RCS SYSTEM
SEE SYS 20

CAMERA VIEWPORT / SPARE

CAMERA VIEWPORT / SPARE

CAMERA VIEWPORT / SPARE

CAMERA VIEWPORT / SPARE

CAMERA VIEWPORT / SPARE

CAMERA VIEWPORT / SPARE

TTA EQUIPMENT DECK

CAMERA VIEWPORT

OVERFLOW TO/FROM TANK TNK-12-001A
12FMD002

CONTAINMENT BUILDING

TANK FOUNDATION

TRANSFER STORAGE TANK TNK-12-001B

SHOWN IN SWRS MODE FROM SILO 2

TANK SUMP SMP-12-001B

SLOPE

TO BUILDING SUMP
12FMD006

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.
3. SHIELD BOX TO BE PLACED OVER E2-48" RISER WHEN NOT IN USE.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

E-3157

CONN FOR DECON SPRAY RINGS IN SLC-11-204
12FMD018

CONNECTION FOR FLUSH WATER IN SLURRY MODULE SLR-11-202

TO FLUSH WATER FOR SLR-11-202 & SPRAY RINGS FOR SLR-11-202 & DEC-12-201
12FMD018

CONN FOR DECON SPRAY RINGS IN SLC-11-205
12FMD018

FROM DOMESTIC WATER SYSTEM VALVE MOV-51-016
51FMD004

AIR SWEEP TO RCS SYSTEM
SEE SYS 20

000338

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/01/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

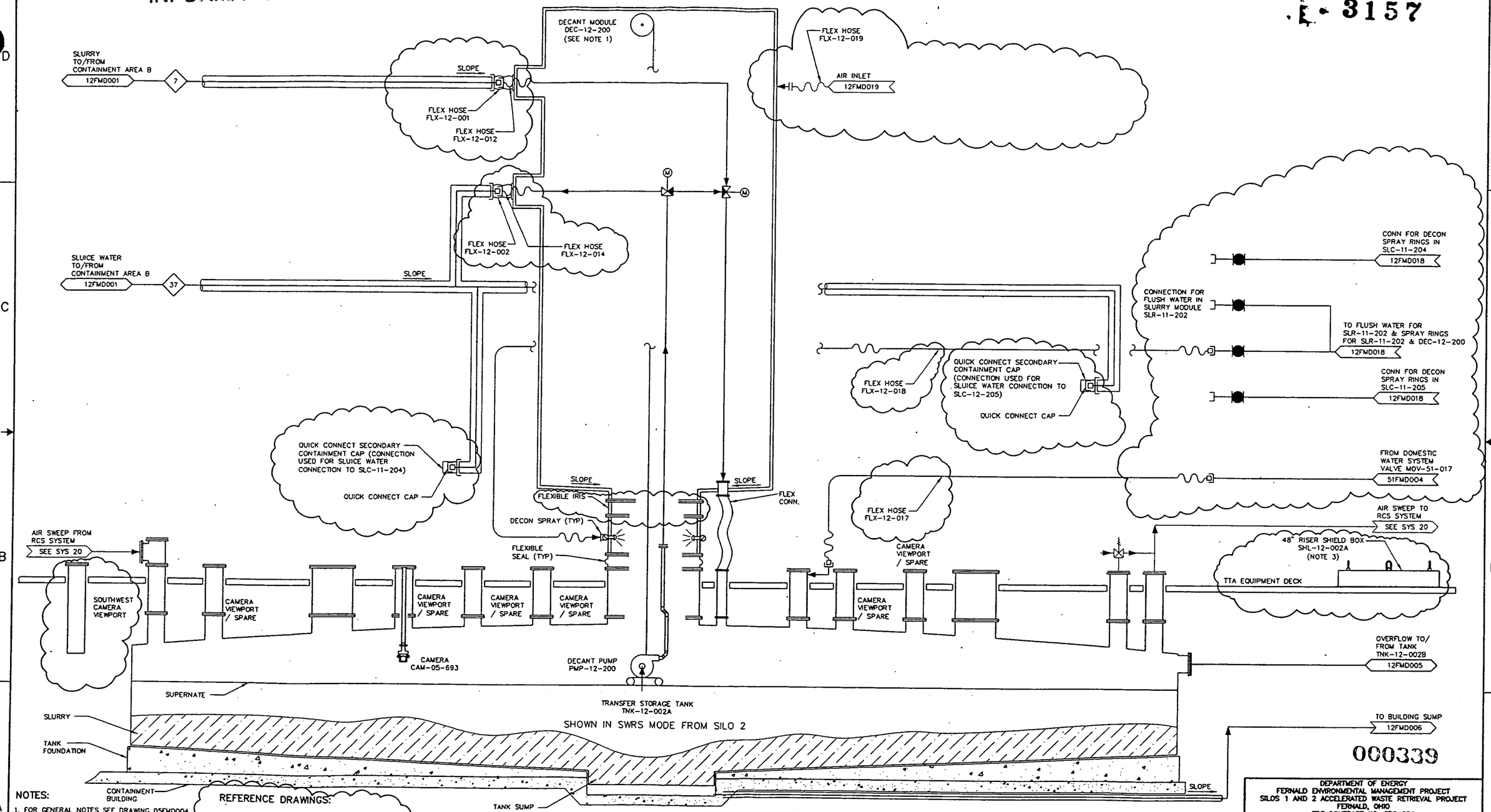
TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
STORAGE TANK TNK-12-001B

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD003	2

FILENAME: 12FMD003.DWG

INFORMATION ONLY

E-3157



000339

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.
3. SHIELD BOX TO BE PLACED OVER E2-48" RISER WHEN NOT IN USE.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
STORAGE TANK TNK-12-002A

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD004	2

FILENAME: 12FMD004.DWG

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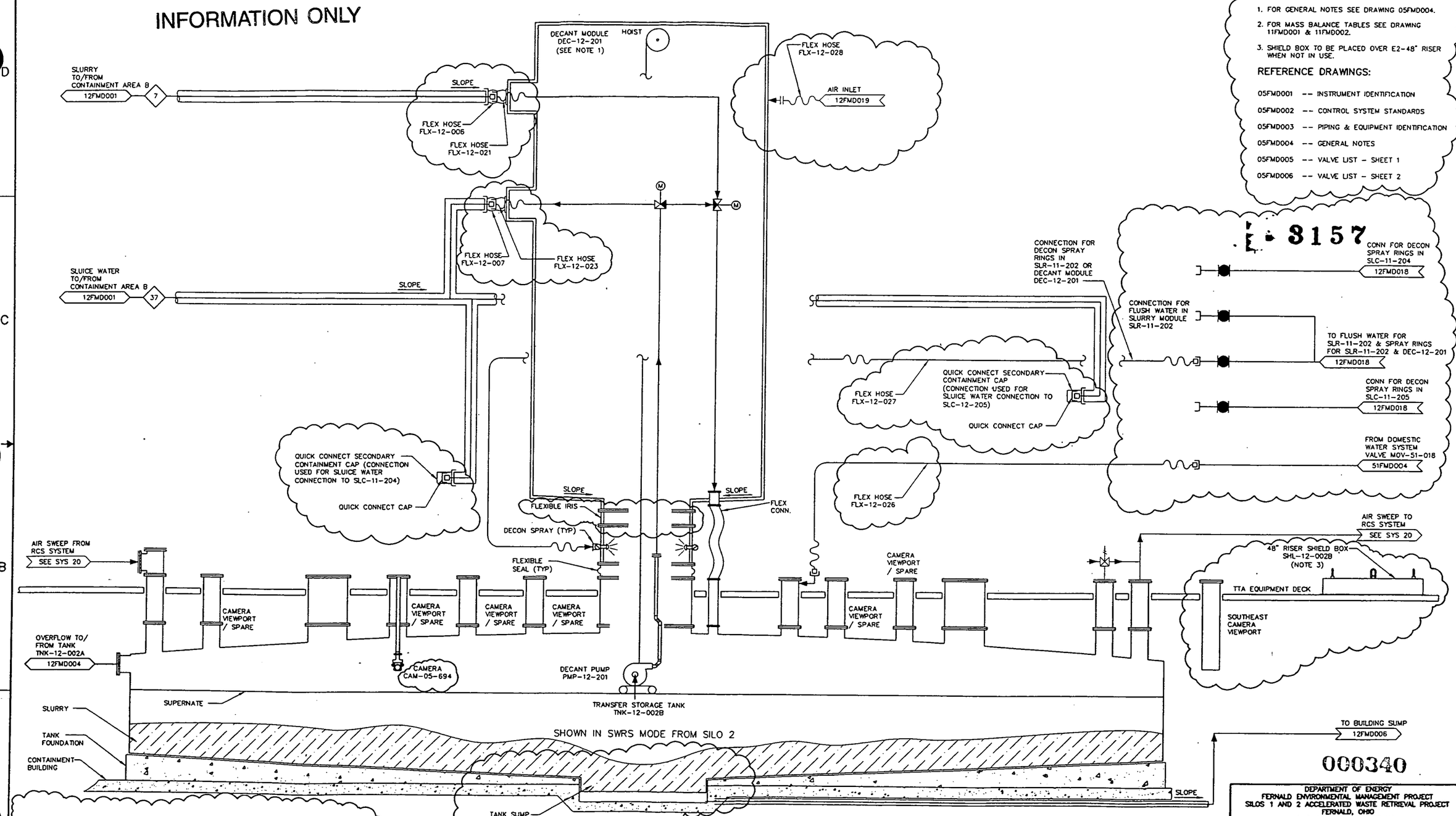
INFORMATION ONLY



NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.
3. SHIELD BOX TO BE PLACED OVER E2-48" RISER WHEN NOT IN USE.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

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THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

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2					REVISED PER CHANGE PROPOSAL CP-00-001
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0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE

TRANSFER TANK SYSTEM PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-002B

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD005	2

FILENAME: 12FMD005.DWG.

INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

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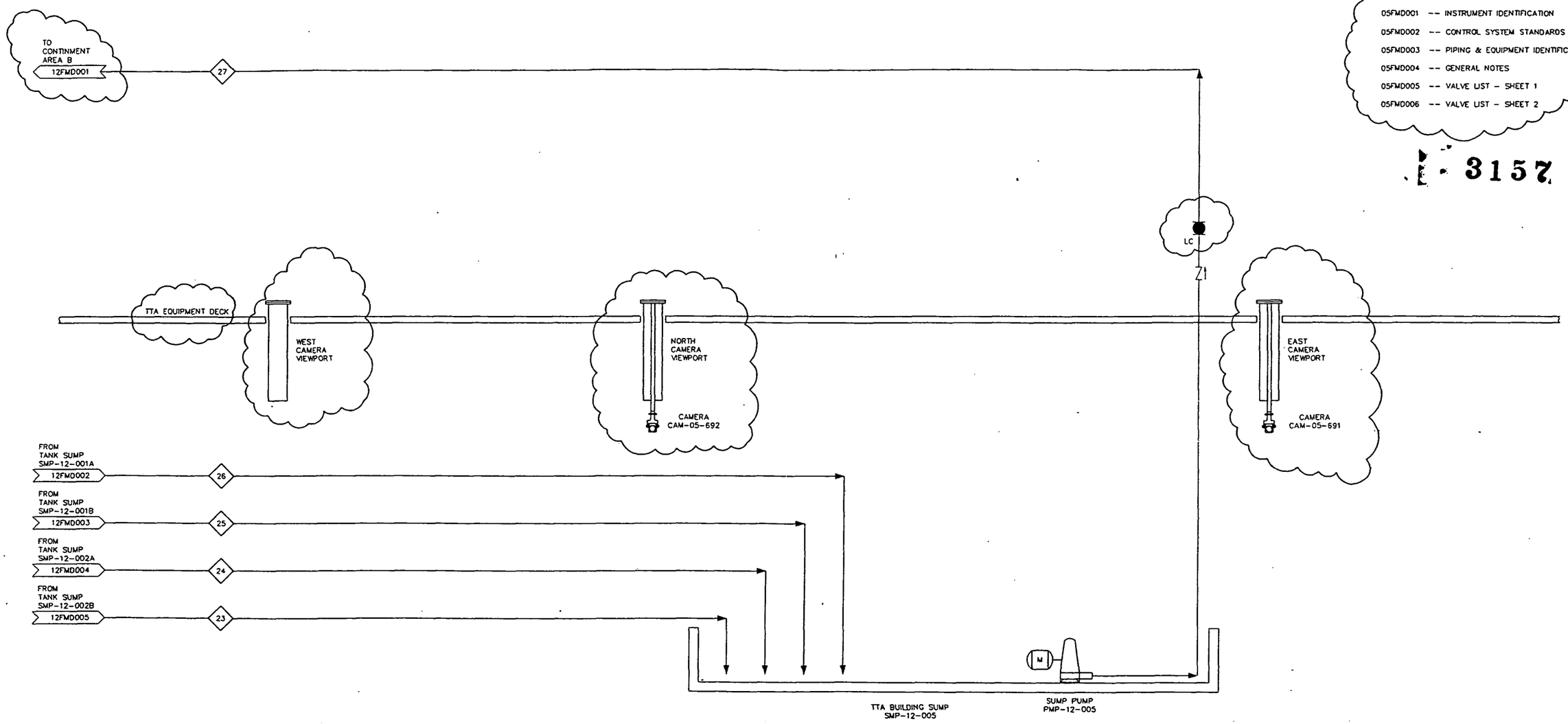

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THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
BUILDING SUMP SMP-12-005

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD006	2

FILENAME: 12FMD006.DWG

INFORMATION ONLY

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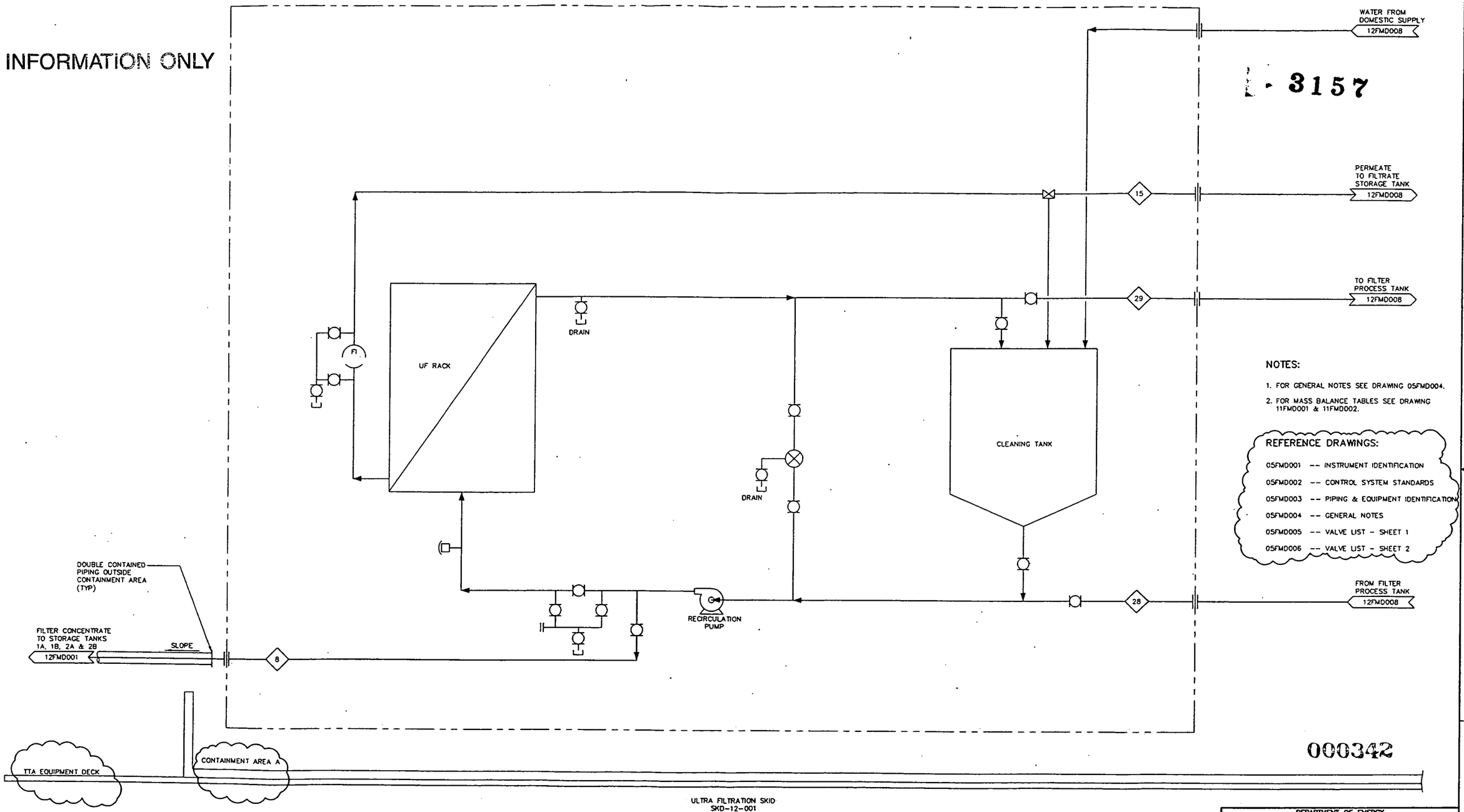

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

000342

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
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0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
ULTRA FILTRATION SKD-12-001

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD007	2

FILENAME: 12FMD007.DWG

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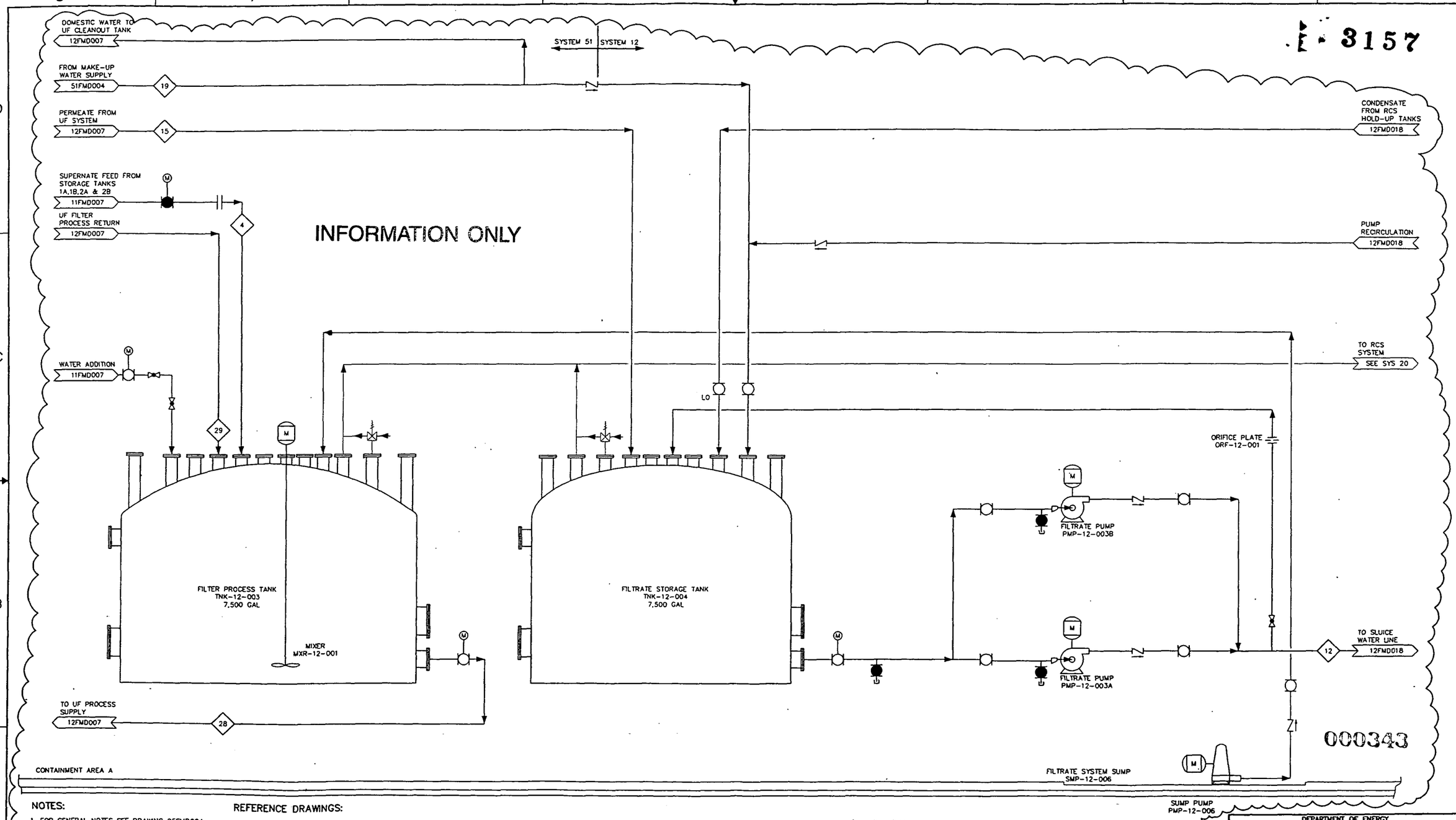

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.
3. SEE DRAWING 11PMD403 FOR DETAILS OF HIGH PRESSURE PUMP SKID SKD-11-252.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/01/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
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PE

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CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

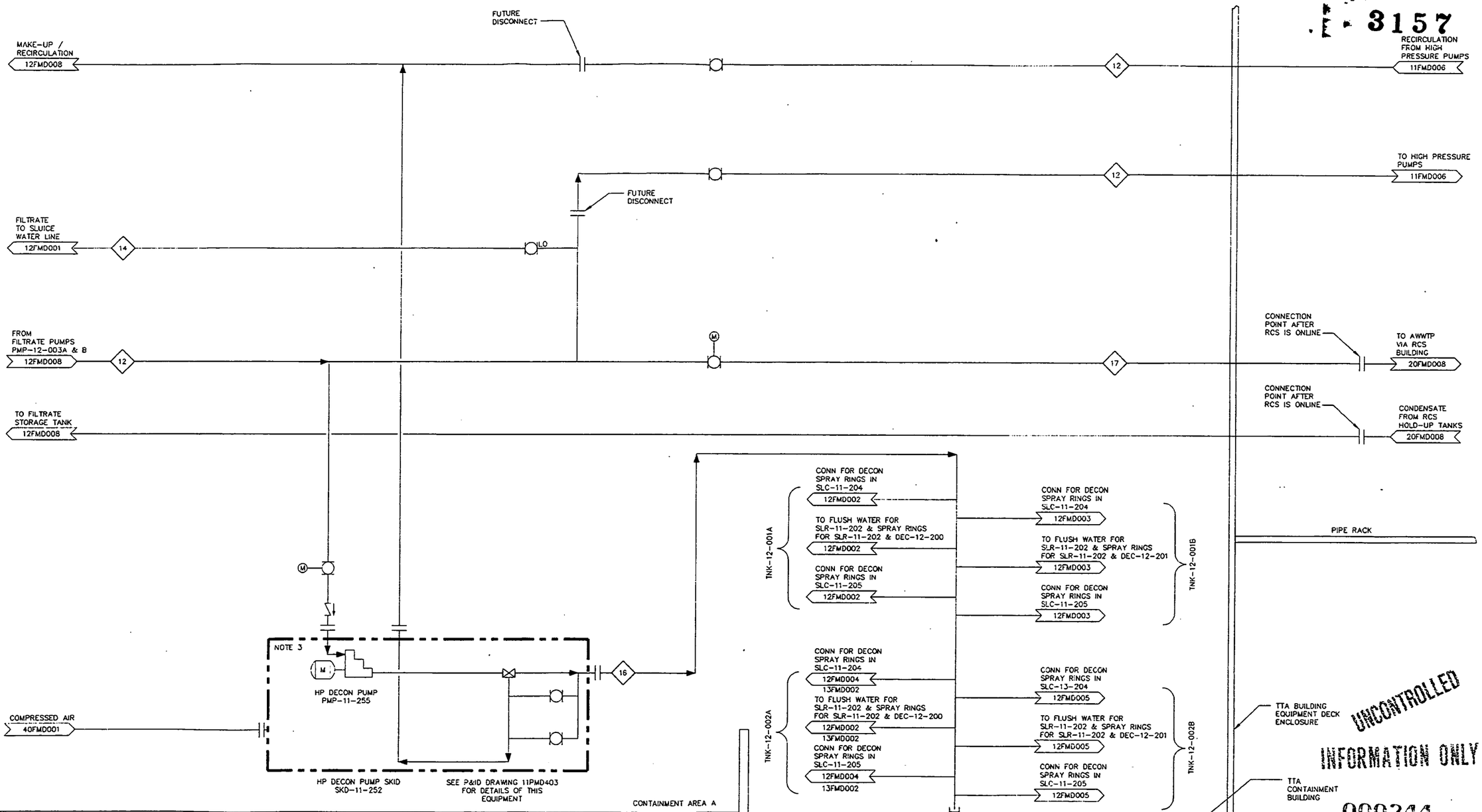
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
FILTRATE SYSTEM (TANKS)

SIZE	SCALE	DWG. NO.	REV
D	NONE	12FMD008	2

FILENAME: 12FMD008.DWG



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UNCONTROLLED

INFORMATION ONLY

000344

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
A					ISSUED FOR 90% REVIEW

RPE

DRAWN BY DATE
DESIGNED BY DATE
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
PROCESS FLOW DIAGRAM
FILTRATE RECIRC & TRANSFER

SIZE	SCALE:	DWG. NO.	REV
D	NONE	12FMD018	A

FILENAME. 12FMD018.DWG

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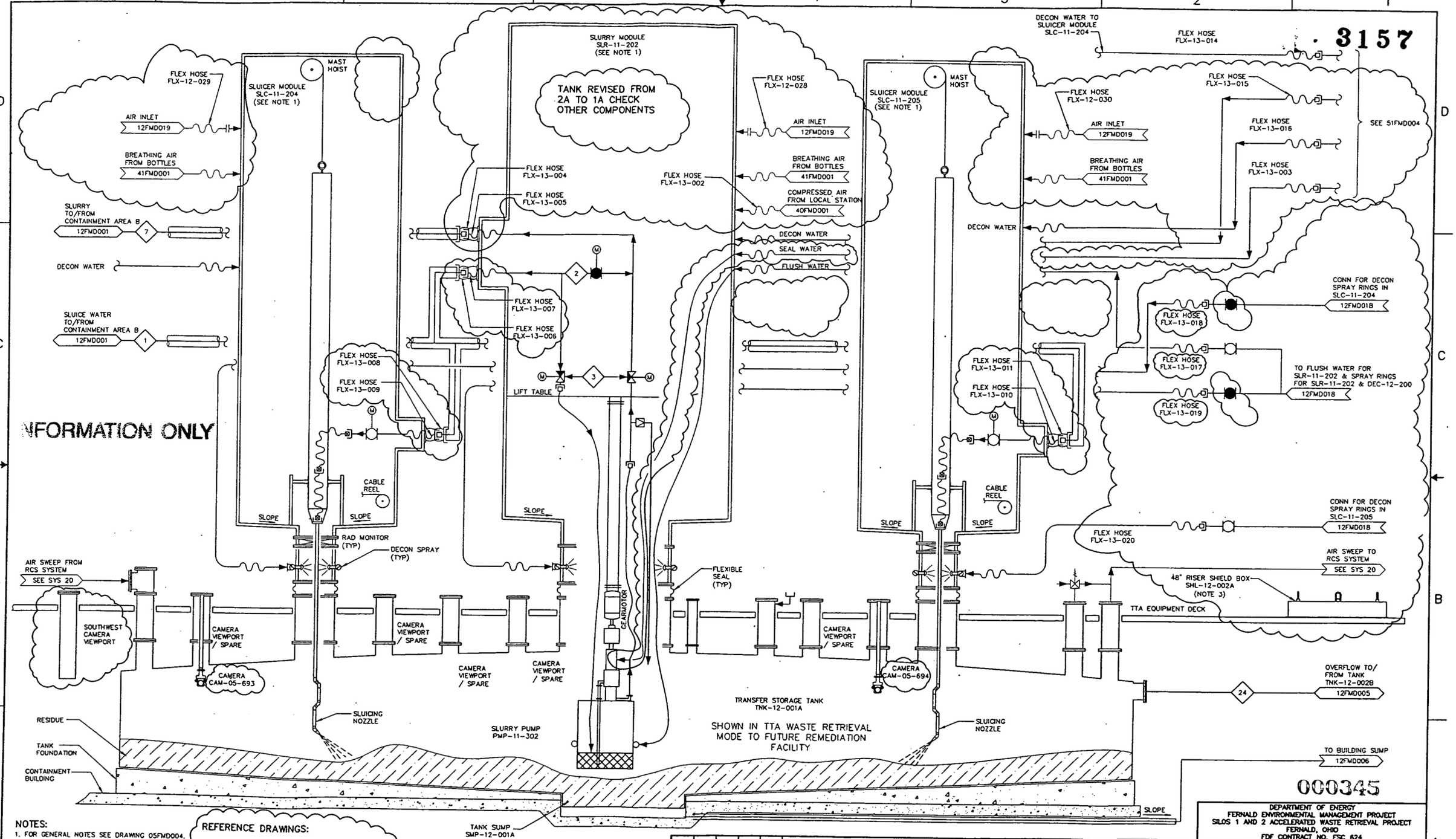

000345

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 13FMD001.
3. SHIELD BOX TO BE PLACED OVER E2-48" RISER WHEN NOT IN USE.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM STORAGE TANK TNK-12-001A

SIZE D | SCALE: NONE | DWG. NO. 13FMD002 | REV 2

FILENAME: 13FMD002.DWG

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INFORMATION ONLY

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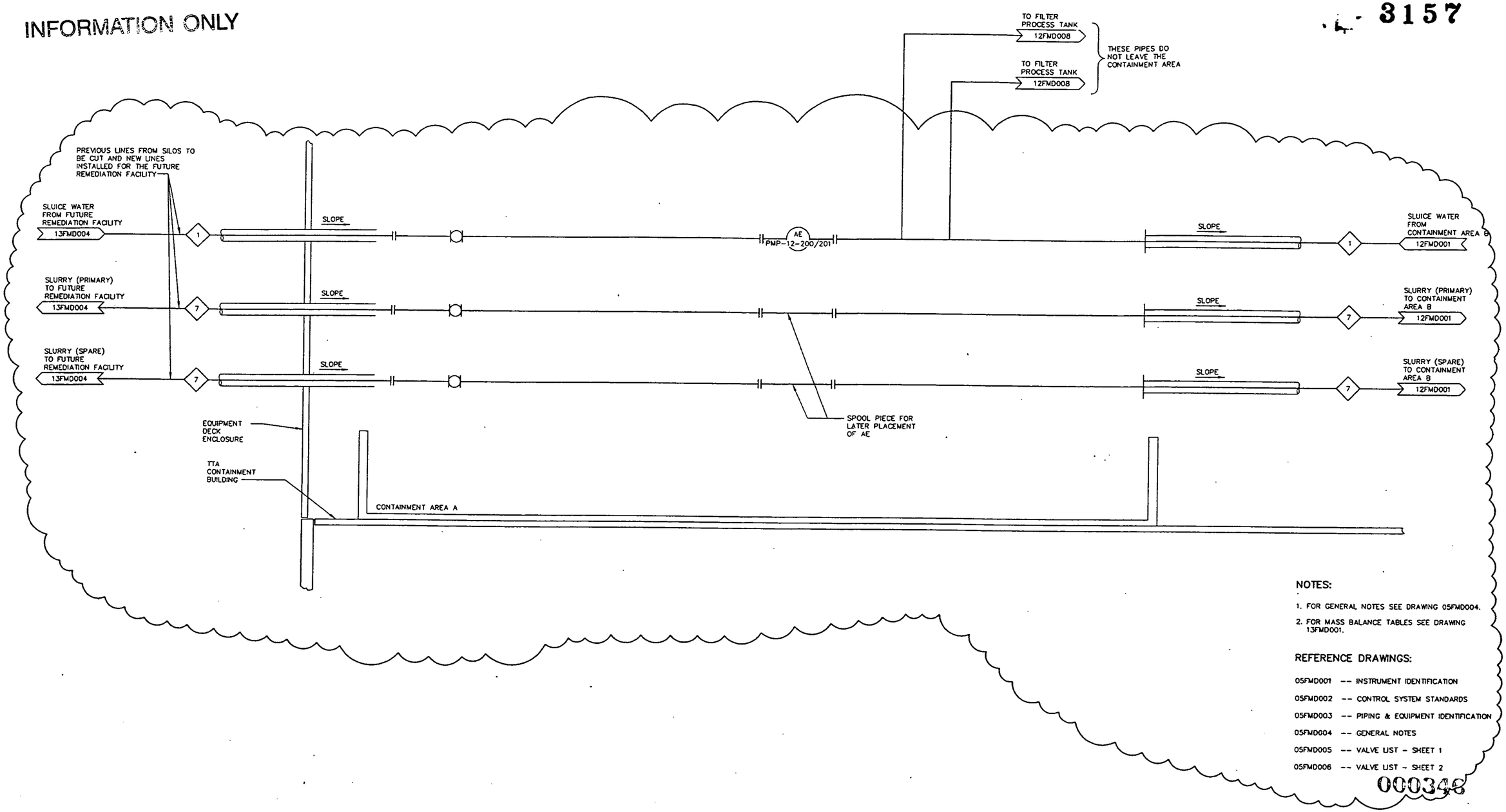

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 13FMD001.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

000348

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
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PE

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DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM
(PROCESS ANALYZER)

SIZE	SCALE:	DWG. NO.	REV
D	NONE	13FMD003	2

FILENAME: 13FMD003.DWG

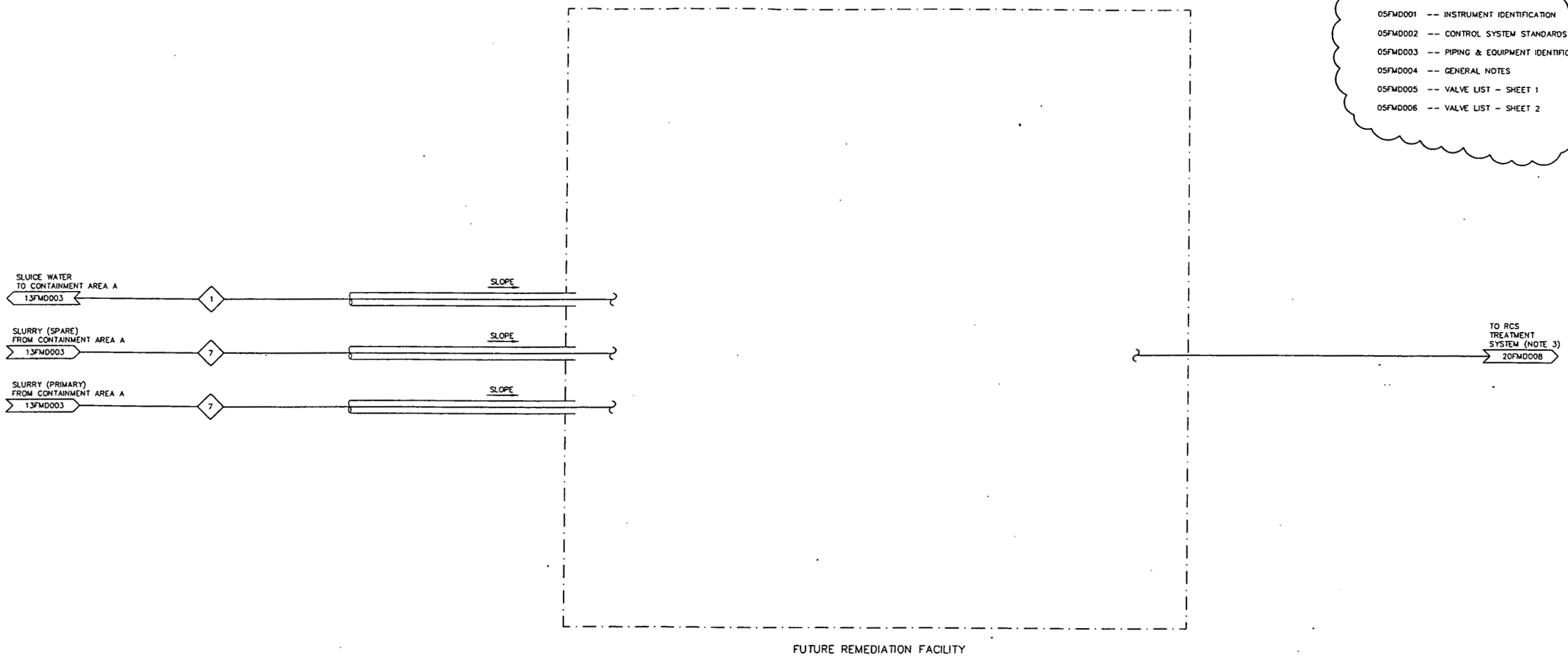
INFORMATION ONLY

NOTES: 3157

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 13FMD001.
3. CORRESPONDS TO STREAM 11 OF RCS - SYSTEM 20.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



000347

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
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PE

DRAWN BY	B J DAVIS	DATE 01/07/00
DESIGNED BY	B J DAVIS	DATE 01/07/00
CHECKED BY	S W HUNGATE	DATE 01/07/00
APPROVED BY	KENNETH RICKETT	DATE 01/07/00
APPROVED BY	JOHN LAWSON	DATE 01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK WASTE RETRIEVAL
PROCESS FLOW DIAGRAM
FUTURE REMEDIATION FACILITY

SIZE	SCALE:	DWG. NO.	REV
D	NONE	13FMD004	2

FILENAME: 13FMD004.DWG

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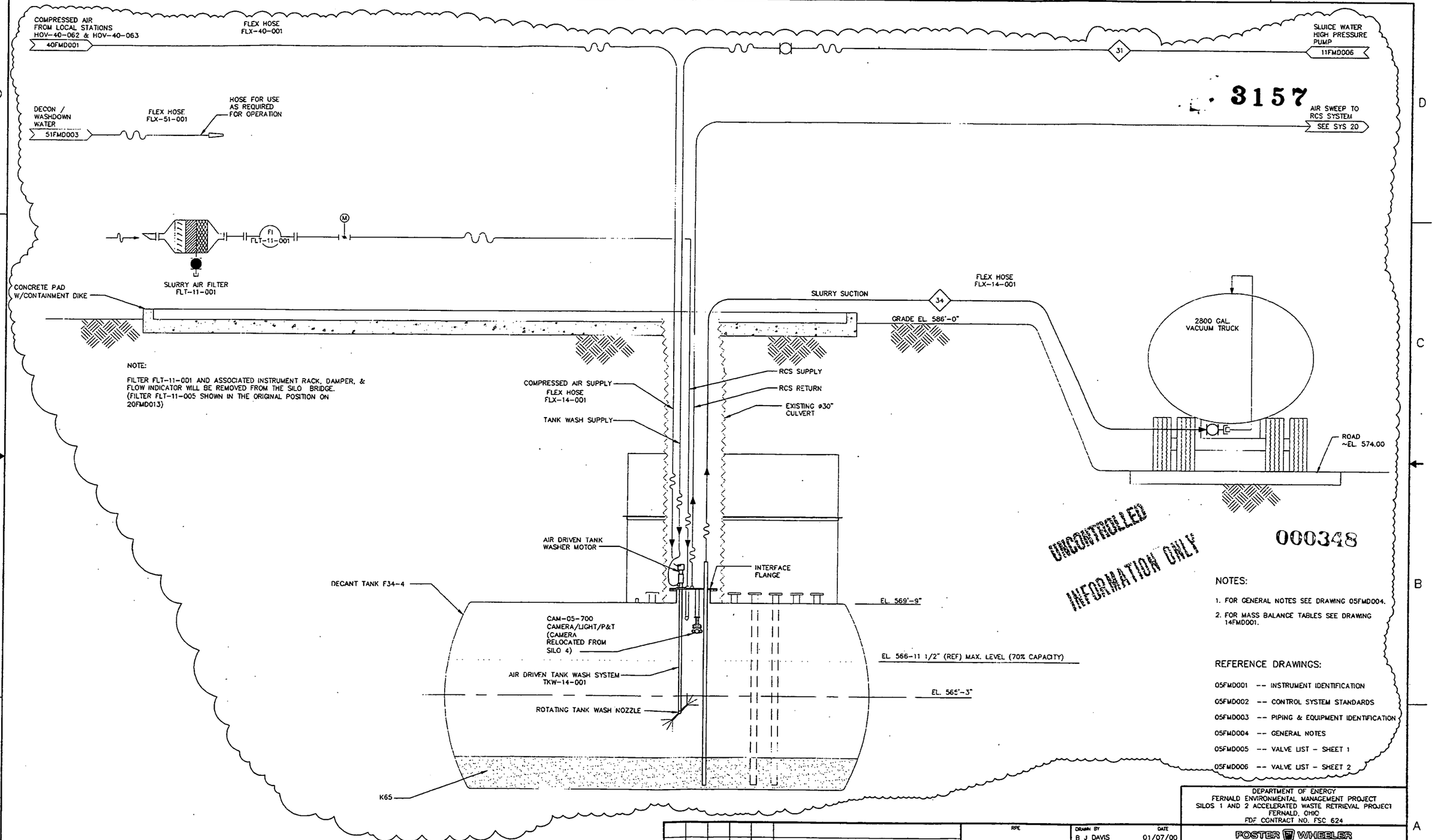

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 14FMD001.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PPE

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DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
DECANT SUMP RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
DECANT SUMP RETRIEVAL

SIZE	SCALE:	DWG. NO.	REV
D	NONE	14FMD002	2

FILENAME: 14FMD002.DWG

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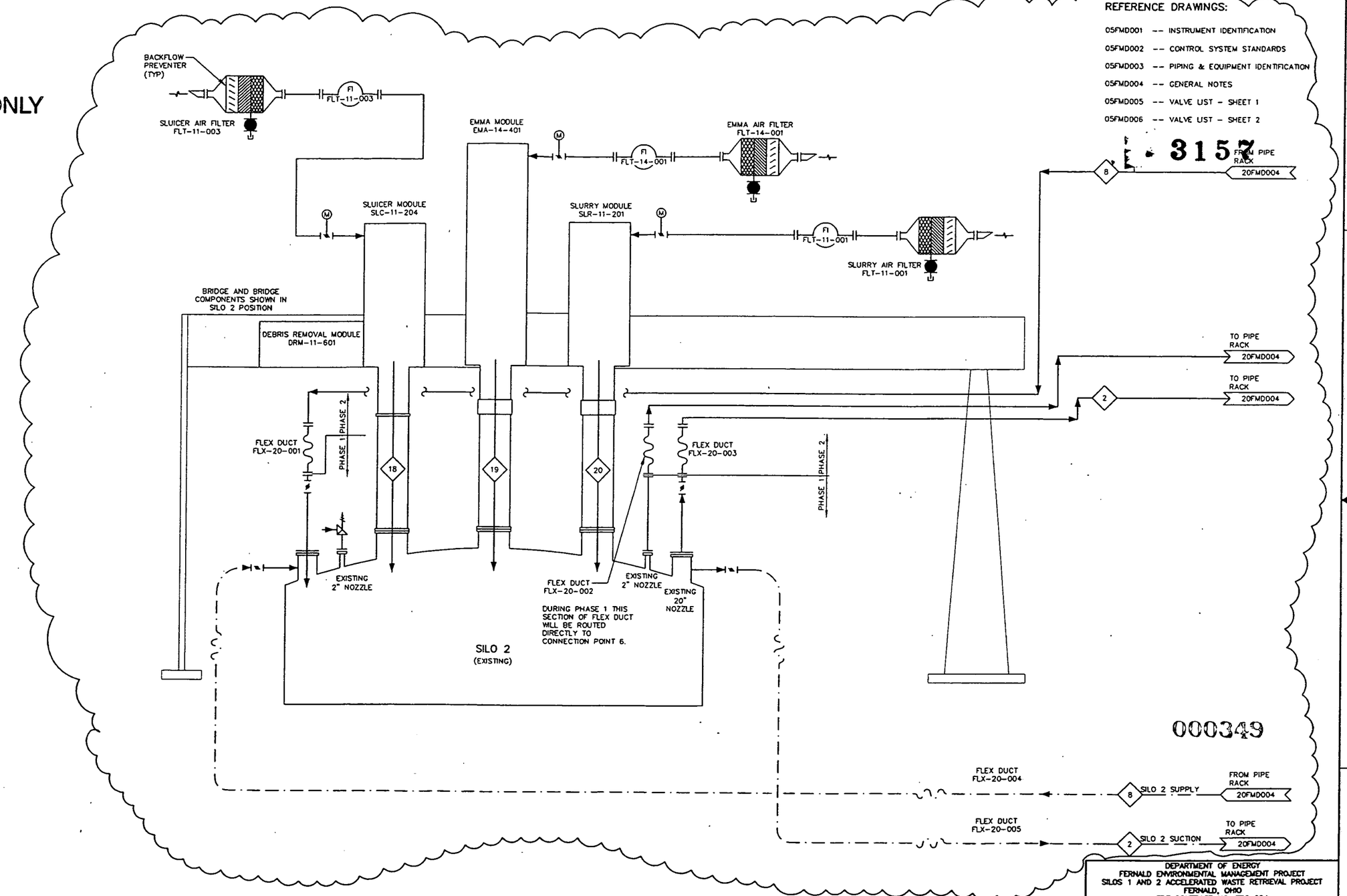
INFORMATION ONLY

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2



E-3157

000349

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	5/15/00	BJD	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE
KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETREIVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
SILO 2

SIZE	SCALE:	DWG. NO.	REV
D	NONE	20FMD003	2

FILENAME: 20FMD003.DWG

U:\DRAWINGS\FEC\3152\20FMD003.dwg, 05/26/2000 03:04:16 PM

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INFORMATION ONLY
UNCONTROLLED

BACKFLOW PREVENTER (TYP)
SLUICER AIR FILTER FLT-11-003
FI FLT-11-003
EMMA MODULE EMA-14-401
FI FLT-14-001
EMMA AIR FILTER FLT-14-001
SLUICER MODULE SLC-11-204
SLURRY MODULE SLR-11-201
FI FLT-11-001
SLURRY AIR FILTER FLT-11-001
BRIDGE AND BRIDGE COMPONENTS SHOWN IN SILO 1 POSITION
DEBRIS REMOVAL MODULE DRM-11-601
FLEX DUCT FLX-20-001
PHASE 1 PHASE 2
EXISTING 20" NOZZLE
EXISTING 2" NOZZLE
FLEX DUCT FLX-20-002
DURING PHASE 1 THIS SECTION OF FLEX DUCT WILL BE ROUTED DIRECTLY TO CONNECTION POINT 7.
EXISTING 20" NOZZLE
FLEX DUCT FLX-20-003
FLEX DUCT FLX-20-007
SILO 1 (EXISTING)
FLEX DUCT FLX-20-006
FLEX DUCT FLX-20-004
FLEX DUCT FLX-20-005
TO SILO 2 20FMD003
FROM SILO 2 20FMD003
FROM DWRS SYSTEM 20FMD011
SILO 1 SUCTION
SILO 1 SUPPLY
SILO 2 SUPPLY
SILO 2 SUCTION
SPOOL PIECE 4 REMOVABLE TO ALLOW BRIDGE ROTATION (TYP)
BLIND FLANGE WHEN NOT IN USE
SPOOL PIECE 1
PHASE 2 PHASE 1
FROM RECIRCULATION FANS 20FMD010
SPOOL PIECE 2
SPOOL PIECE 5 REMOVABLE TO ALLOW BRIDGE ROTATION (TYP)
SPOOL PIECE 6 REMOVABLE TO ALLOW BRIDGE ROTATION (TYP)
SPOOL PIECE 3
TO TREATMENT SYSTEM 20FMD009
PIPE RACK
RCS PHASE 2 PIPE RACK CONSTRUCTION
RCS PHASE 1 PIPE RACK CONSTRUCTION
20FMD004 20FMD013

BLIND FLANGE WHEN NOT IN USE
AIR FLOW
CONDENSATE TRAP
1 DETAIL SCALE: NONE
2 DETAIL SCALE: NONE
20FMD004 20FMD013

NOTES:

1. FOR NOTES SEE DRAWINGS 20FMD003, & 20FMD012

LEGEND:

(1) = INDICATES CONNECTION POINTS FOR PIPING.

= INDICATES FLEX PIPING FOR PHASE 1

000350

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
3					REVISED PER --------
2	05/15/00	BJD	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

RME

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
SILO 1

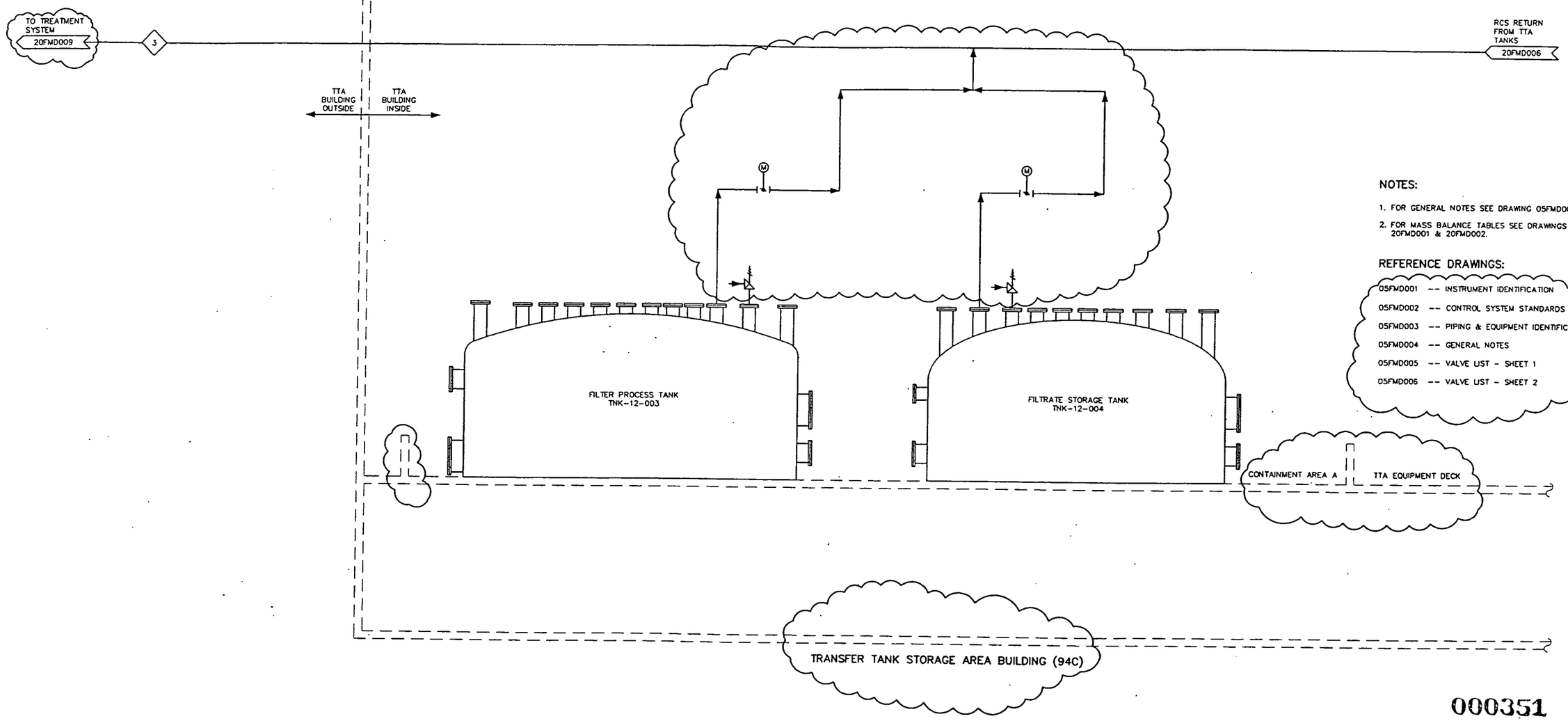
SIZE	SCALE:	DWG. NO.	REV
D	NONE	20FMD004	3

FILENAME: 20FMD004.DWG

R:\CHARGEVER\SILOS\WR\20fmd004.dwg Thu Jun 22 15:31:11 2000

INFORMATION ONLY

3157



NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

000351

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

RPE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
FILTER & FILTRATE STORAGE TNKS

SIZE: D | SCALE: NONE | DWG. NO. 20FMD005 | REV 2

FILENAME: 20FMD005.DWG

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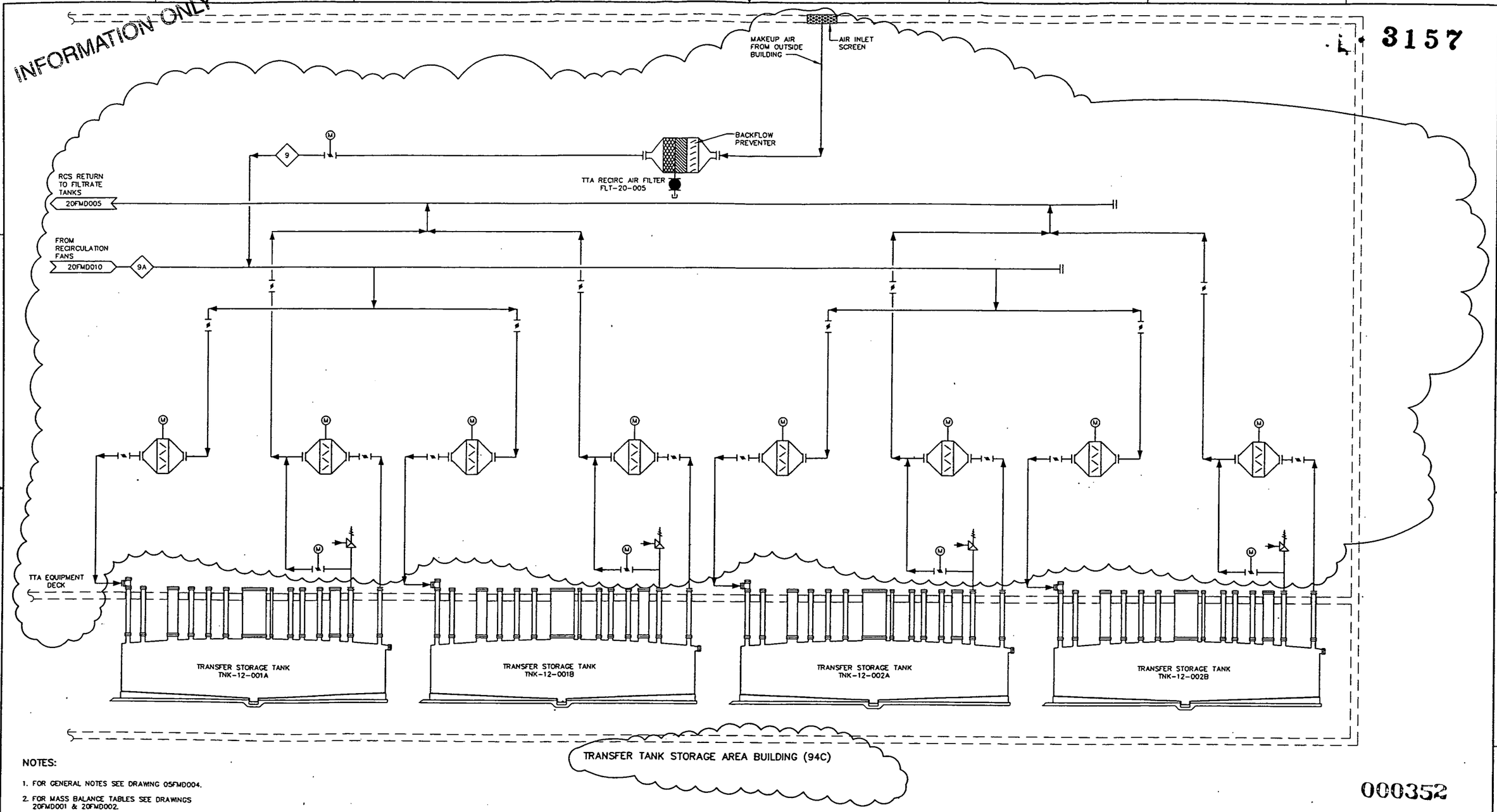
INFORMATION ONLY

3157



000352

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE UST - SHEET 1
05FMD006 -- VALVE UST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
TTA STORAGE TANKS

SIZE D | SCALE: NONE | DWG. NO. 20FMD006 | REV 2

FILENAME: 20FMD006.DWG

G:\CHARGE\FD C:\SYS20\20fmd006.dwg, 05/26/2000 03:05:19 PM

INFORMATION ONLY

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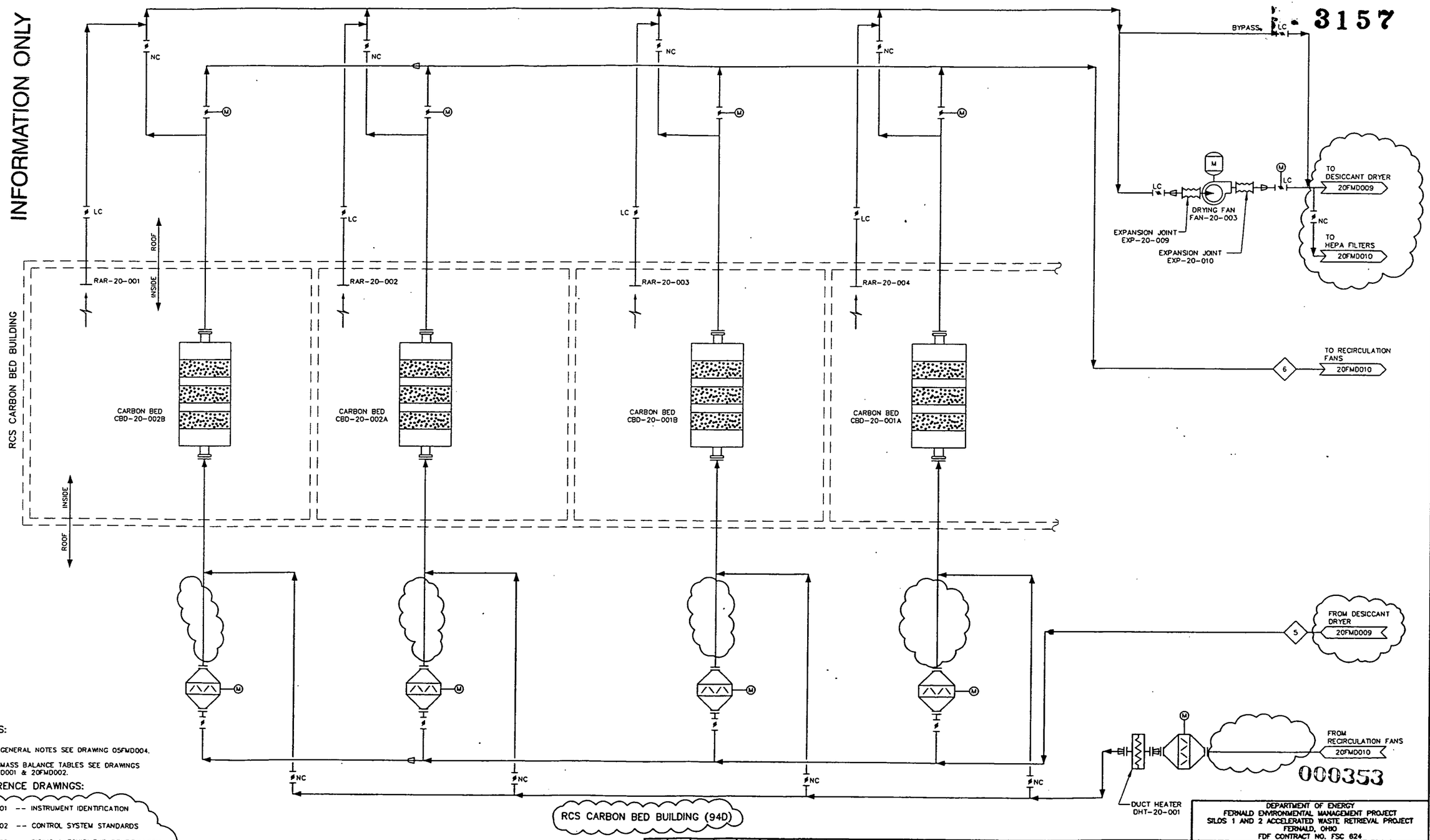

000353

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

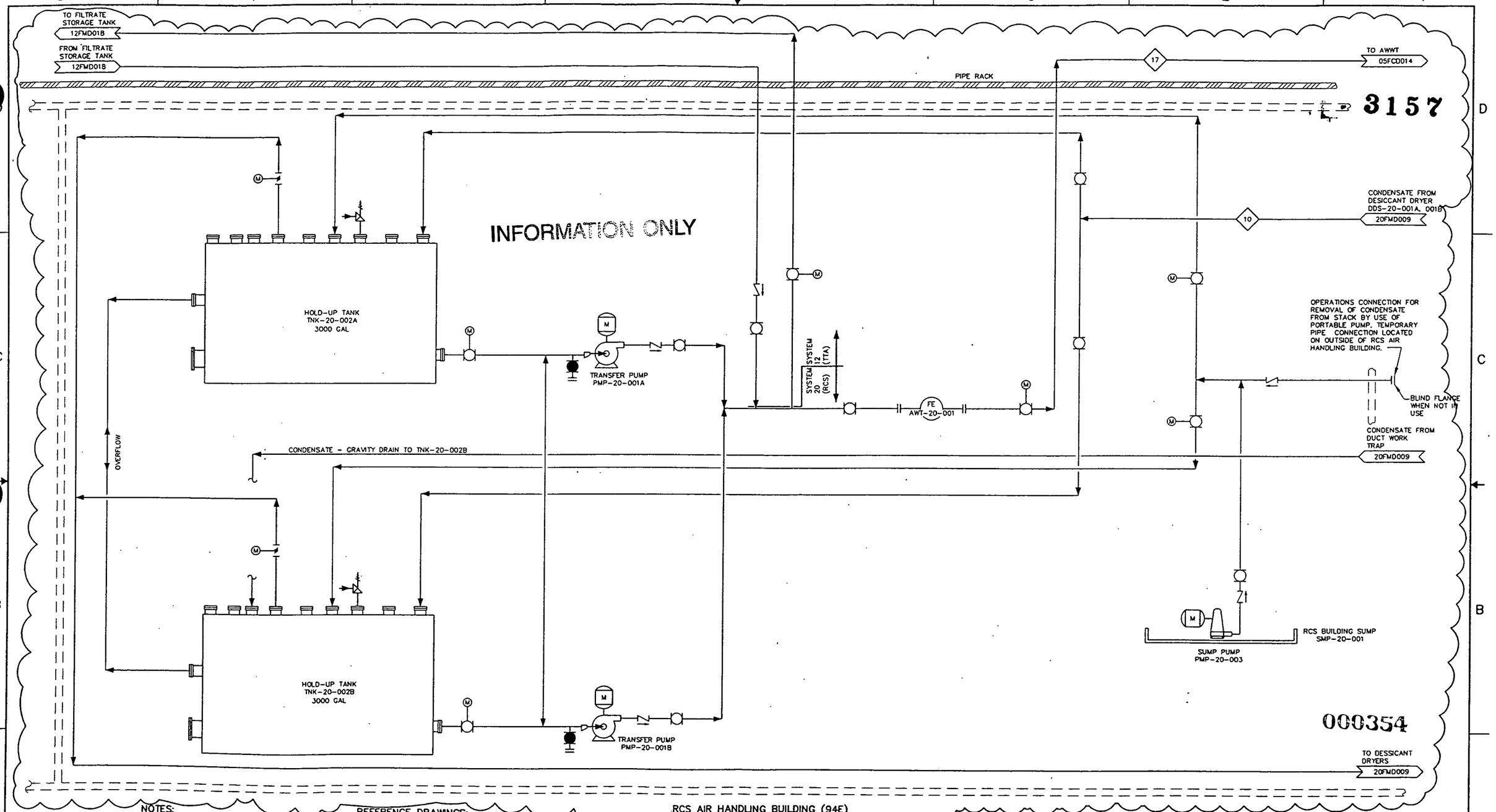
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
CARBON BEDS

SIZE: D | SCALE: NONE | DWG. NO. 20FMD007 | REV 2

FILENAME: 20FMD007.DWG



NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.
3. DESICCANT DRYING SYSTEM INCLUDES PRECOOLING COIL, DESICCANT WHEEL, POST-COOLING COIL, CLOSED LOOP REACTIVATION SYSTEM, CONDENSATE COLLECTION TRANSFER SYSTEM, AND INSTRUMENTATION.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD001 -- CONTROL SYSTEM STANDARDS
05FMD001 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD001 -- GENERAL NOTES
05FMD001 -- VALVE LIST - SHEET 1
05FMD001 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
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APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
HOLD-UP TANKS & CONDENSATE

SIZE	SCALE	DWG. NO.	REV
D	NONE	20FMD008	2

FILENAME: 20FMD008.DWG

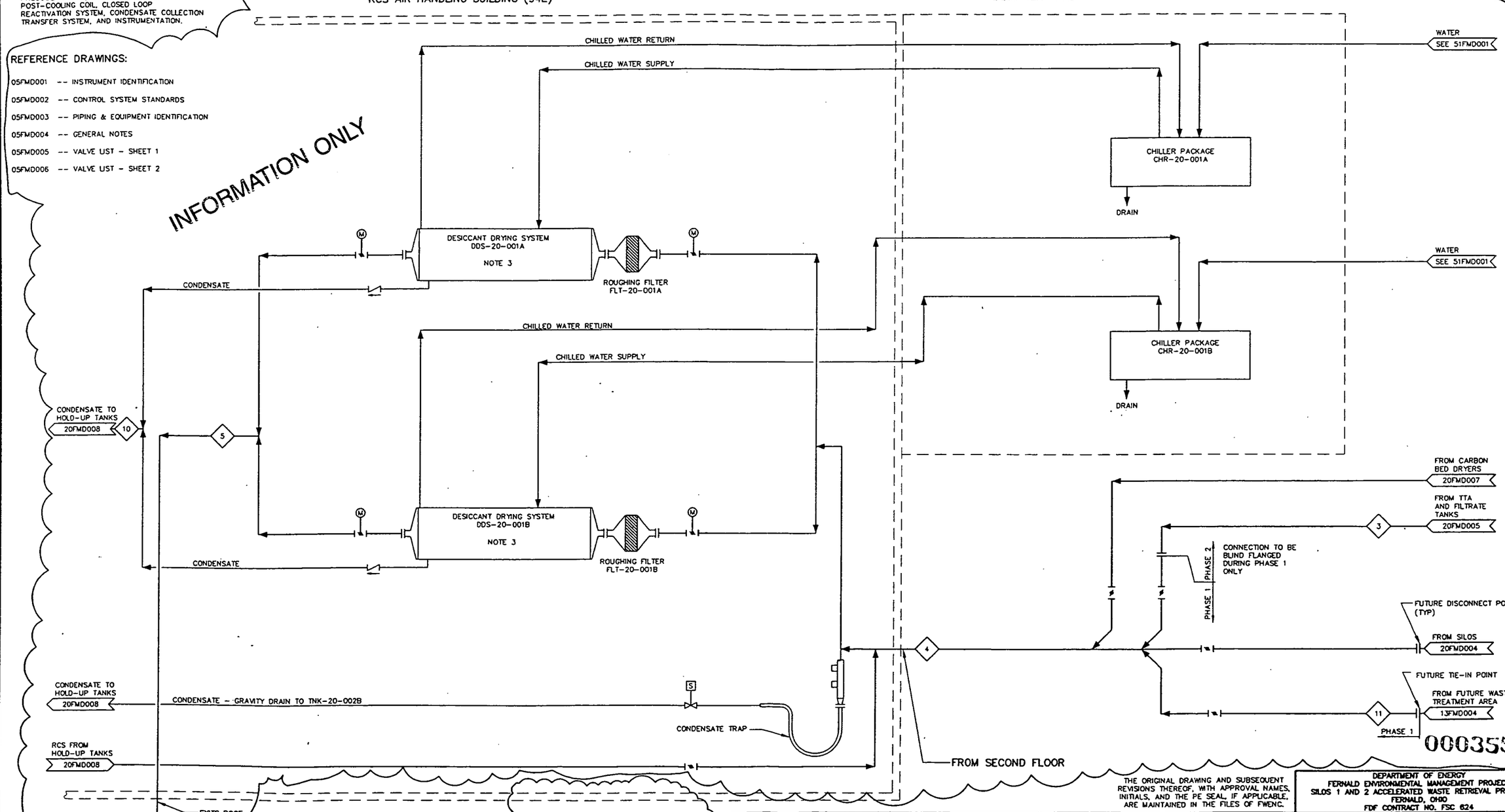
3157

NOTES:
1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.
3. DESICCANT DRYING SYSTEM INCLUDES PRECOOLING COIL, DESICCANT WHEEL, POST-COOLING COIL, CLOSED LOOP REACTIVATION SYSTEM, CONDENSATE COLLECTION TRANSFER SYSTEM, AND INSTRUMENTATION.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

INFORMATION ONLY



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THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
DRYERS & AIR HANDLING

SIZE: D | SCALE: NONE | DWG. NO. 20FMD009 | REV 2

FILENAME: 20FMD009.DWG

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INFORMATION ONLY

TO SILOS 20FMD004

TO CARBON BED DUCT HEATER DHT-20-001 20FMD007

FROM DRYING FAN 20FMD007

FROM CARBON BEDS 20FMD007

CONNECTION TO BE BLIND FLANGED DURING PHASE 1 ONLY

PHASE 1 | PHASE 2

TO TTA 20FMD006

PIPE RACK TO TTA

MAKEUP AIR FROM OUTSIDE BUILDING

BACKFLOW PREVENTER

MAKE-UP AIR FILTER FLT-20-004

AIR INLET SCREEN

RCS BUILDING - 2ND FLOOR

TO ATM

SAMPLE

SAMPLE RETURN

CONTINUOUS EMISSIONS MONITORING BUILDING

BACKDRAFT DAMPER

FROM VENTILATION SYSTEM 77FMD005

STACK STK-20-001

BLIND FLANGE WHEN NOT IN USE

CONNECTION FOR REMOVAL OF CONDENSATE FROM STACK BY USE OF PORTABLE PUMP BY OPERATIONS. TEMPORARY PIPE TO BE CONNECTED TO OUTSIDE OF RCS AIR HANDLING BUILDING.

HEPA FILTER FLT-20-002A

HEPA FILTER FLT-20-002B

EXPANSION JOINT EXP-20-001

EXHAUST / RECIRCULATION FAN FAN-20-001A

EXPANSION JOINT EXP-20-002

EXPANSION JOINT EXP-20-003

EXHAUST / RECIRCULATION FAN FAN-20-001B

EXPANSION JOINT EXP-20-004

RCS AIR HANDLING BUILDING (94E) - 2ND FLOOR

000356

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWINGS 20FMD001 & 20FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD002 -- CONTROL SYSTEM STANDARDS
05FMD003 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD004 -- GENERAL NOTES
05FMD005 -- VALVE LIST - SHEET 1
05FMD006 -- VALVE LIST - SHEET 2

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	BJD	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT, P.E. NO. E-64418, 5/15/00, REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE: RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM EXHAUST & RECIRC FANS

SIZE: D | SCALE: NONE | DWG. NO. 20FMD010 | REV 2

FILENAME: 20FMD010.DWG

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INFORMATION ONLY

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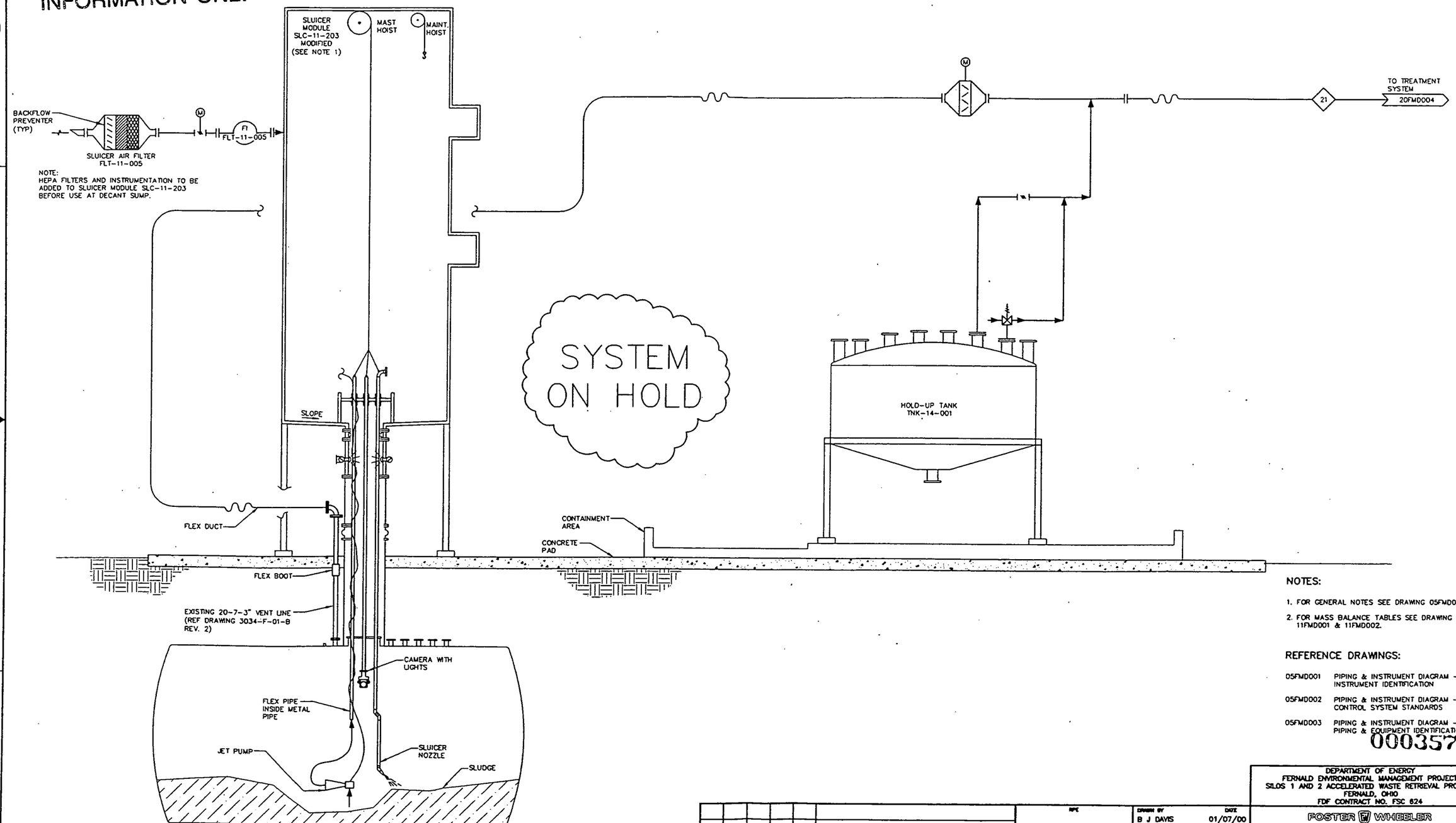

NOTE:
HEPA FILTERS AND INSTRUMENTATION TO BE ADDED TO SLUICER MODULE SLC-11-203 BEFORE USE AT DECANT SUMP.

NOTES:

1. FOR GENERAL NOTES SEE DRAWING 05FMD004.
2. FOR MASS BALANCE TABLES SEE DRAWING 11FMD001 & 11FMD002.

REFERENCE DRAWINGS:

05FMD001 PIPING & INSTRUMENT DIAGRAM – INSTRUMENT IDENTIFICATION

05FMD002 PIPING & INSTRUMENT DIAGRAM – CONTROL SYSTEM STANDARDS

05FMD003 PIPING & INSTRUMENT DIAGRAM – PIPING & EQUIPMENT IDENTIFICATION

000357

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE

DRAWN BY B J DAVIS	DATE 01/07/00	
DESIGNED BY B J DAVIS	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
PROCESS FLOW DIAGRAM
DECANT WASTE RETRIEVAL

SIZE	SCALE:	DWG. NO.	REV
D	NONE	20FMD011	1

FILENAME: 20FMD011.DWG

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INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE P

2. FOR MASS BALANCE
11FMD001 & 11FM

REFERENC

05D RUMENT DIAGRAM –
T IDENTIFICATION

NG & INSTRUMENT DIAGRAM –
CONTROL SYSTEM STANDARDS

03 PIPING & INSTRUMENT DIAGRAM –
PIPING & EQUIPMENT IDENTIFICATION

3157

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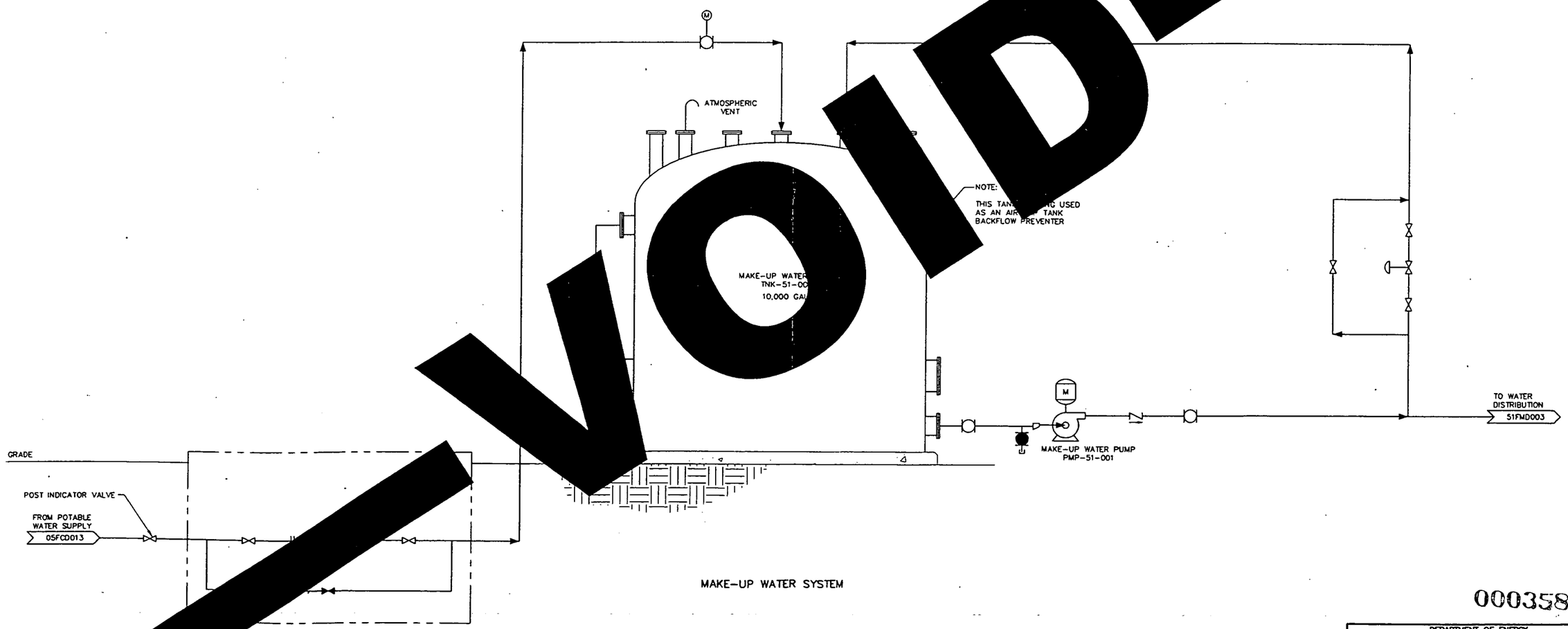

MAKE-UP WATER SYSTEM

000358

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	BJD	GCH	KDR	DRAWING VOID PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	SWH		PRELIMINARY DESIGN PACKAGE

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
POTABLE/DOMESTIC WATER SYS
PROCESS FLOW DIAGRAM
MAKE-UP WATER

SIZE	SCALE:	DWG. NO.	REV
D	NONE	51FMD001	2

FILENAME: 51FMD001.DWG

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INFORMATION ONLY

STORAGE TRAILER (T-411)

STORAGE TRAILER (T-412)

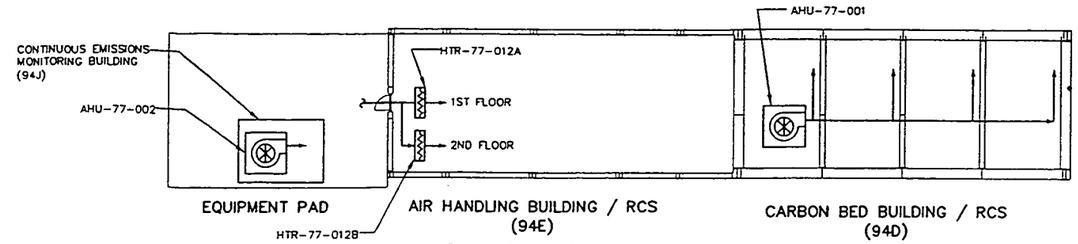
CONTROL TRAILER (T-409)

ELECTRICAL EQUIPMENT BUILDING (94G)

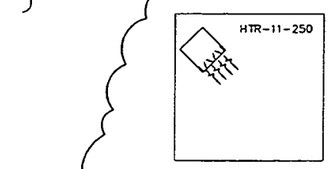
SUPPORT TRAILERS

STORAGE TRAILERS WILL NOT BE HEATED OR COOLED.

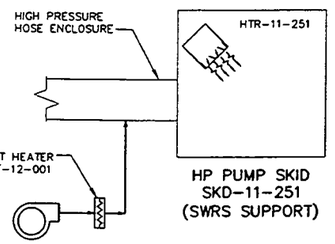
CONTROL TRAILER SUPPLIED WITH INDEPENDENT HEATING AND COOLING UNITS.



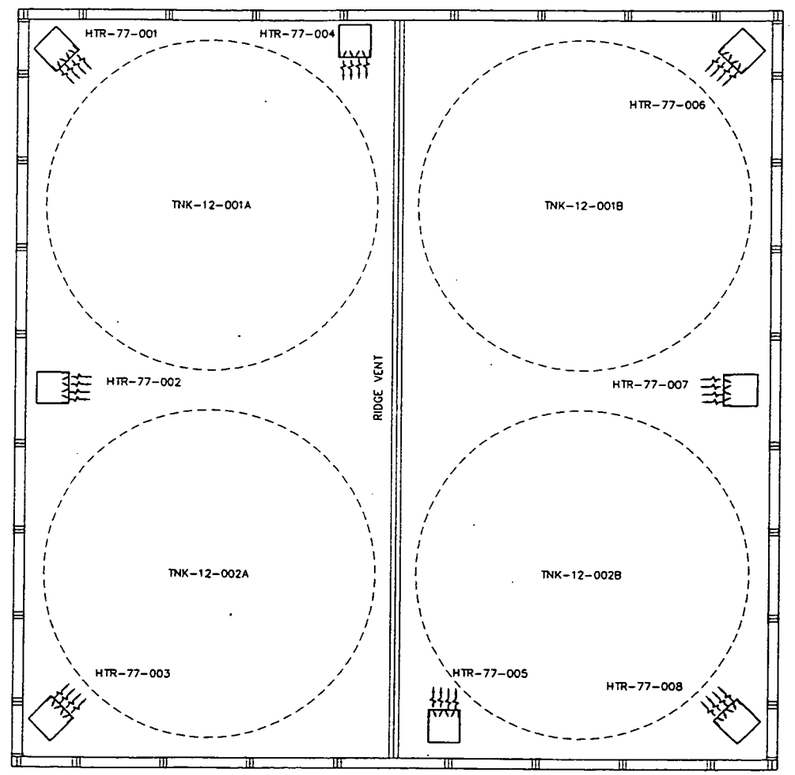
1. AIR HANDLING BUILDING & CARBON BED BUILDING HEATED BY AN ELECTRIC DUCT HEATER.
2. VENTILATION PROVIDED BY A VENTILATION SYSTEM. SEE DRAWINGS 77FMD003, 77FMD005, 77FMD006, & 77FMD008 FOR DETAILS.



HP PUMP SKID SKD-11-250 (FSM SUPPORT)



HP PUMP SKID SKD-11-251 (SWRS SUPPORT)



TANK TRANSFER AREA BUILDING (94C)

1. VENTILATION PROVIDED BY LOUVERS AND A RIDGE VENT.

HOLD

SUPPORT TRAILERS

1. ALL TRAILERS SUPPLIED WITH INDEPENDENT HEATING AND COOLING UNITS

H&S TRAILER (T-408)

H&S TRAILER (T-407)

BREAK TRAILER (T-406)

BREAK TRAILER (T-405)

OFFICE TRAILER (T-404)

OFFICE TRAILER (T-403)

EQUIPMENT MODULES

1. AIR LOCKS ARE PROVIDED WITH EACH ENCLOSURE.
2. RADIANT HEATERS ARE PROVIDED WITH EACH ENCLOSURE FOR FREEZE PROTECTION.
3. VENTILATION OF MODULES ARE PROVIDED BY THE RADON CONTROL SYSTEM. SEE SYSTEM 20 DRAWING FOR DETAILS.
4. SEE DRAWING 05FMD005 FOR MODULE LOCATIONS.

DECANT MODULE DEC-12-200	SLUICER MODULE SLC-11-204
DECANT MODULE DEC-12-201	SLUICER MODULE SLC-11-205
SLURRY MODULE SLR-11-200	EMMA MODULE EMA-14-400
SLURRY MODULE SLR-11-201	EMMA MODULE EMA-14-401
SLURRY MODULE SLR-11-202	DEBRIS REMOVAL MODULE DRM-11-600
SLUICER MODULE SLC-11-203	DEBRIS REMOVAL MODULE DRM-11-601

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	05/15/00	BJD			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
B	01/07/00	BJD			ISSUED FOR OHIO EPA REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY BJD DATE 5-15-00
DESIGNED BY BJD DATE 5-15-00
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC FLOW DIAGRAM
LOCATION AND CONTROL

SIZE D | SCALE: NONE | DWG. NO. 77FMD001 | REV C

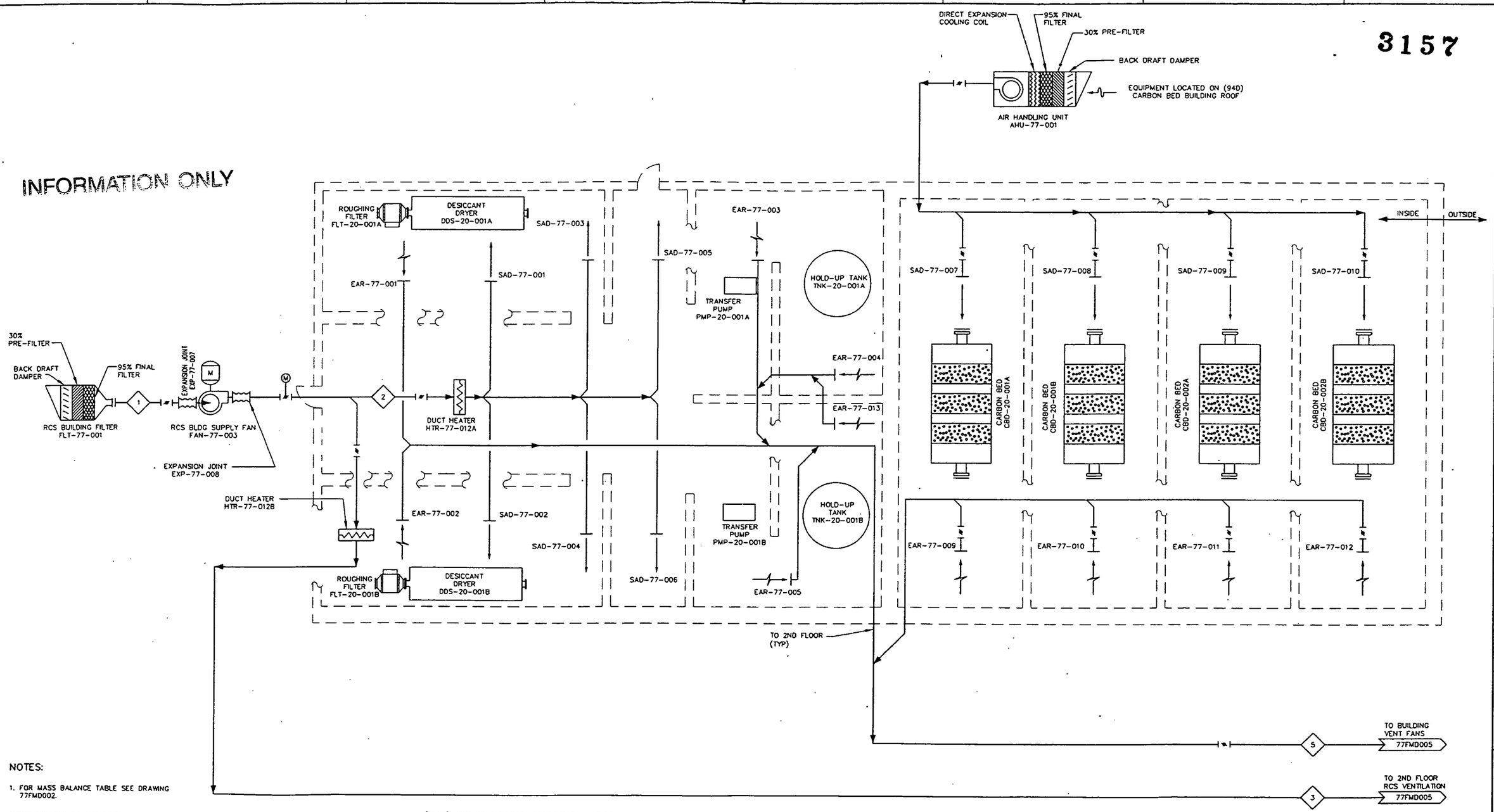
FILENAME: 77FMD001.DWG

000359

L-3157

3157

INFORMATION ONLY



NOTES:

1. FOR MASS BALANCE TABLE SEE DRAWING 77FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD001 -- CONTROL SYSTEM STANDARDS
05FMD001 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD001 -- GENERAL NOTES
05FMD001 -- VALVE LIST - SHEET 1
05FMD001 -- VALVE LIST - SHEET 2

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	05/15/00	BJD			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
B	01/07/00	BJD			ISSUED FOR OHIO EPA REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY BJD DATE 5-15-00
DESIGNED BY BJD DATE 5-15-00
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

000360

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC FLOW DIAGRAM
RCS BLDG VENTILATION-1ST FL

SIZE D | SCALE: NONE | DWG. NO. 77FMD003 | REV C

FILENAME: 77FMD003.DWG

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INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAW
2. FOR MASS BALANCE TABL
77FMD002.

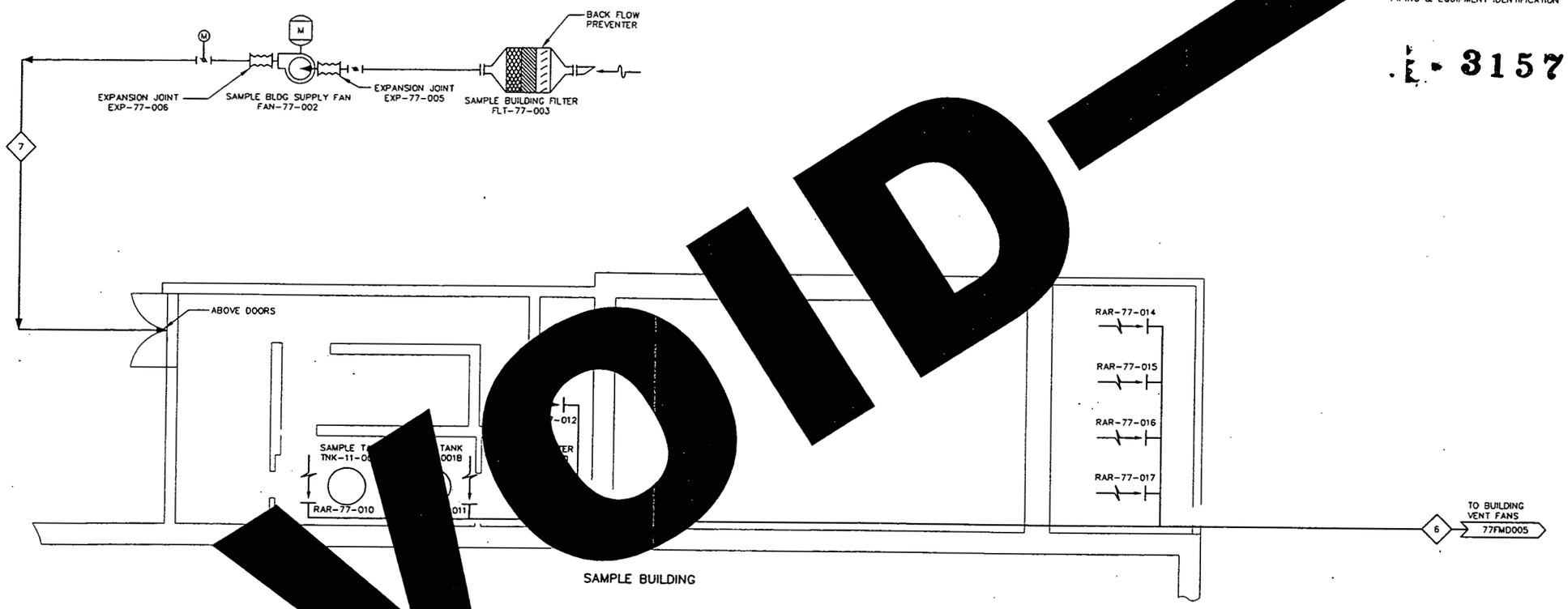
REFERENC

05F RUMENT DIAGRAM – IDENTIFICATION

G & INSTRUMENT DIAGRAM – CONTROL SYSTEM STANDARDS

03 PIPING & INSTRUMENT DIAGRAM – PIPING & EQUIPMENT IDENTIFICATION

E-3157



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000361

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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B	01/07/00	BJD			ISSUED FOR OHIO EPA REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

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DRAWN BY BJD DATE
DESIGNED BY BF DATE
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC FLOW DIAGRAM
SAMPLE BUILDING VENTILATION

SIZE D | SCALE: NONE | DWG. NO. 77FMD004 | REV C

FILENAME: 77FMD004.DWG

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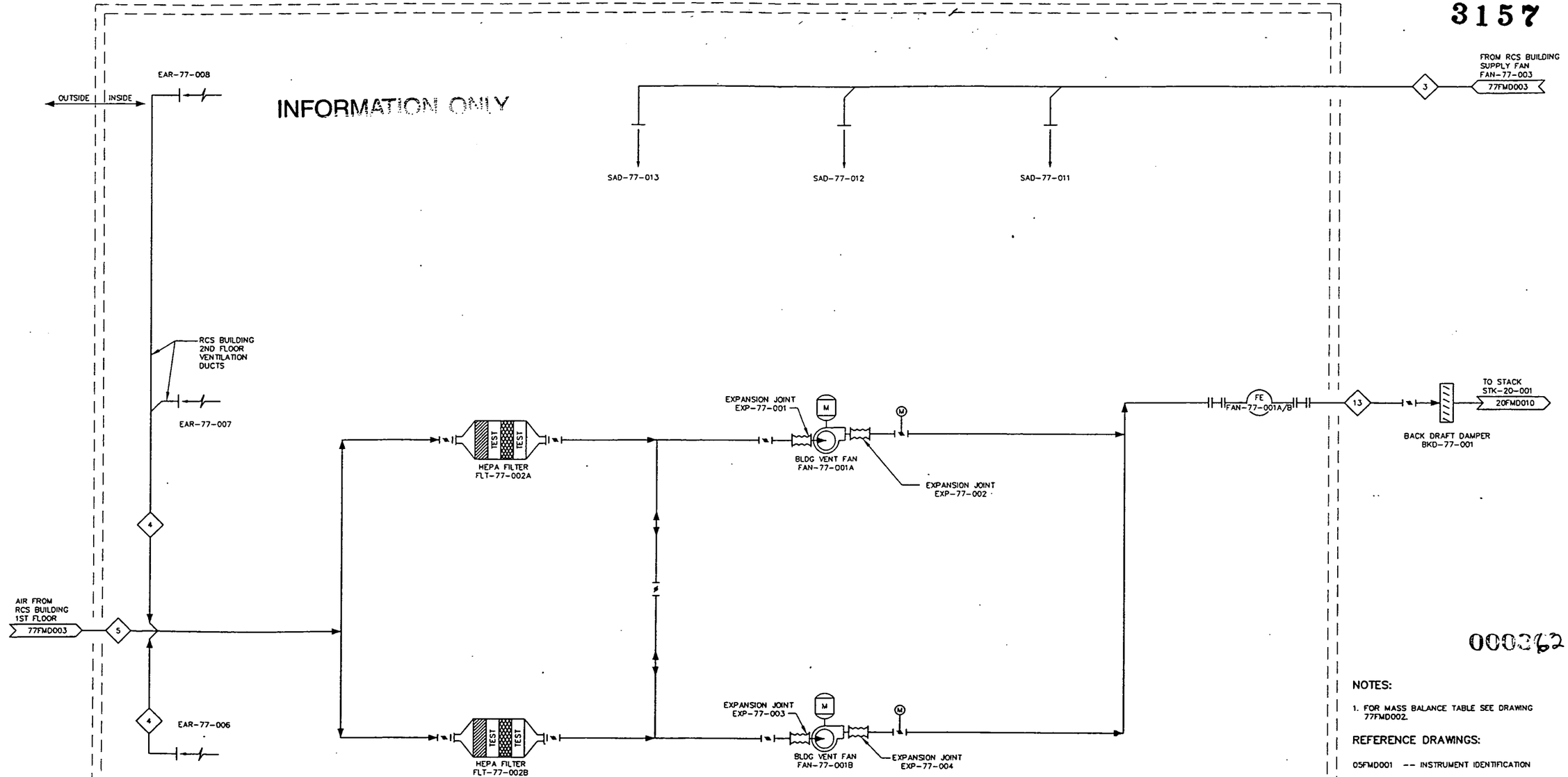
INFORMATION ONLY



000362

(94E) AIR HANDLING BUILDING – RCS
2ND FLOOR

NOTES:

1. FOR MASS BALANCE TABLE SEE DRAWING 77FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD001 -- CONTROL SYSTEM STANDARDS
05FMD001 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD001 -- GENERAL NOTES
05FMD001 -- VALVE LIST – SHEET 1
05FMD001 -- VALVE LIST – SHEET 2

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	05/15/00	BJD			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
B	01/07/00	BJD			ISSUED FOR OHIO EPA REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY BJD	DATE 5-15-00
DESIGNED BY BJD	DATE 5-15-00
CHECKED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC FLOW DIAGRAM
RCS BLDG VENTILATION–2ND FL

SIZE	SCALE	DWG. NO.	REV
D	NONE	77FMD005	C

FILENAME: 77FMD005.DWG

INFORMATION ONLY

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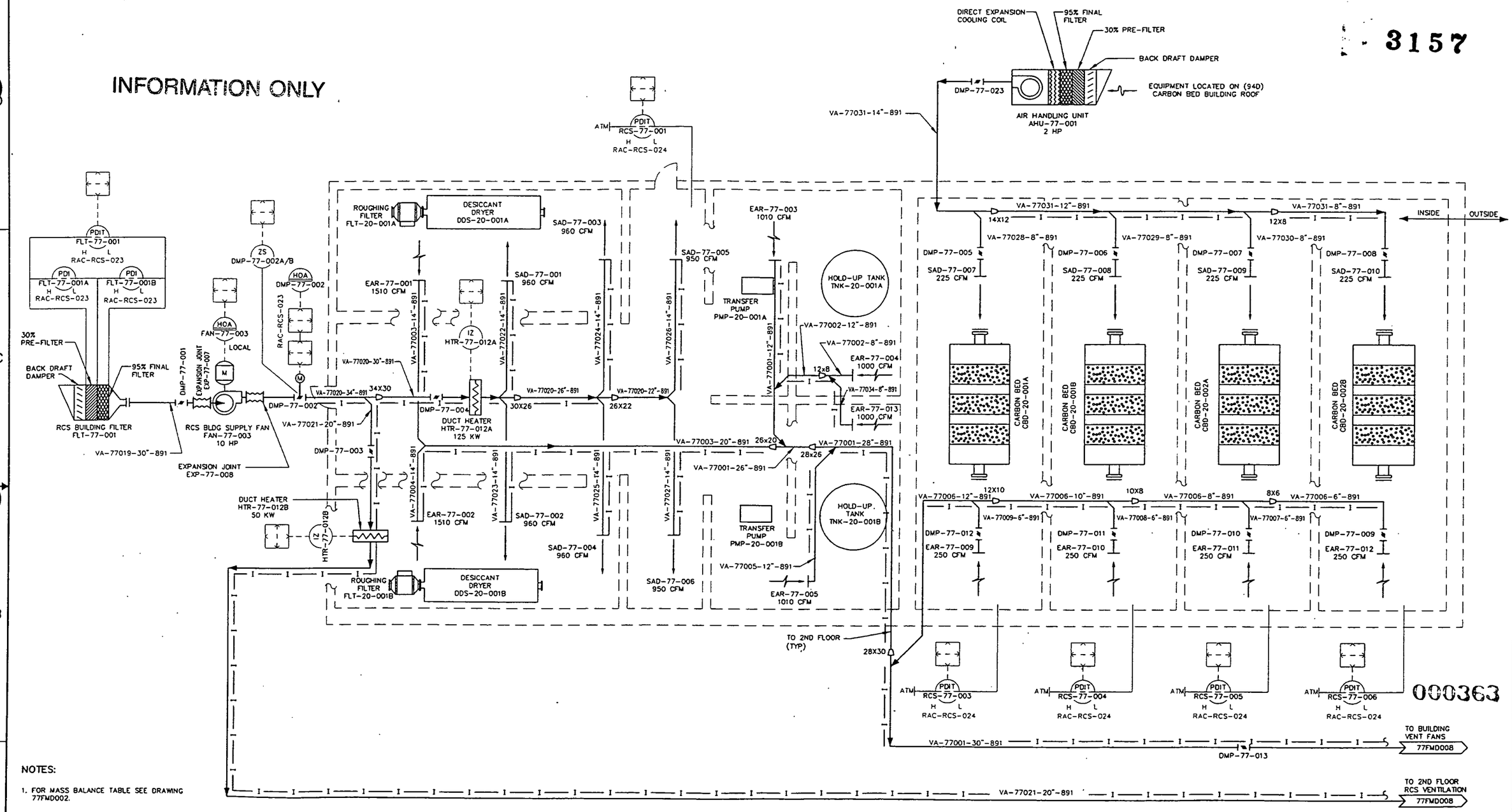

(94E) AIR HANDLING BUILDING – RCS
1ST FLOOR

(94D) CARBON BED BUILDING – RCS
1ST FLOOR

NOTES:

1. FOR MASS BALANCE TABLE SEE DRAWING 77FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD001 -- CONTROL SYSTEM STANDARDS
05FMD001 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD001 -- GENERAL NOTES
05FMD001 -- VALVE LIST – SHEET 1
05FMD001 -- VALVE LIST – SHEET 2

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
B	05/15/00	BJD			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

RPE

		DATE
DRAWN BY	BJD	5-15-00
DESIGNED BY	BJD	5-15-00
CHECKED BY		
APPROVED BY		
APPROVED BY		

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC CONTROL DIAGRAM
RCS BLDG VENTILATION–1ST FL

SIZE	SCALE	DWG. NO.	REV
D	NONE	77FMD006	B

FILENAME: 77FMD006.DWG

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INFORMATION ONLY

NOTES:

1. FOR GENERAL NOTES SEE DRAWI
2. FOR MASS BALANCE TABL
77FMD002.

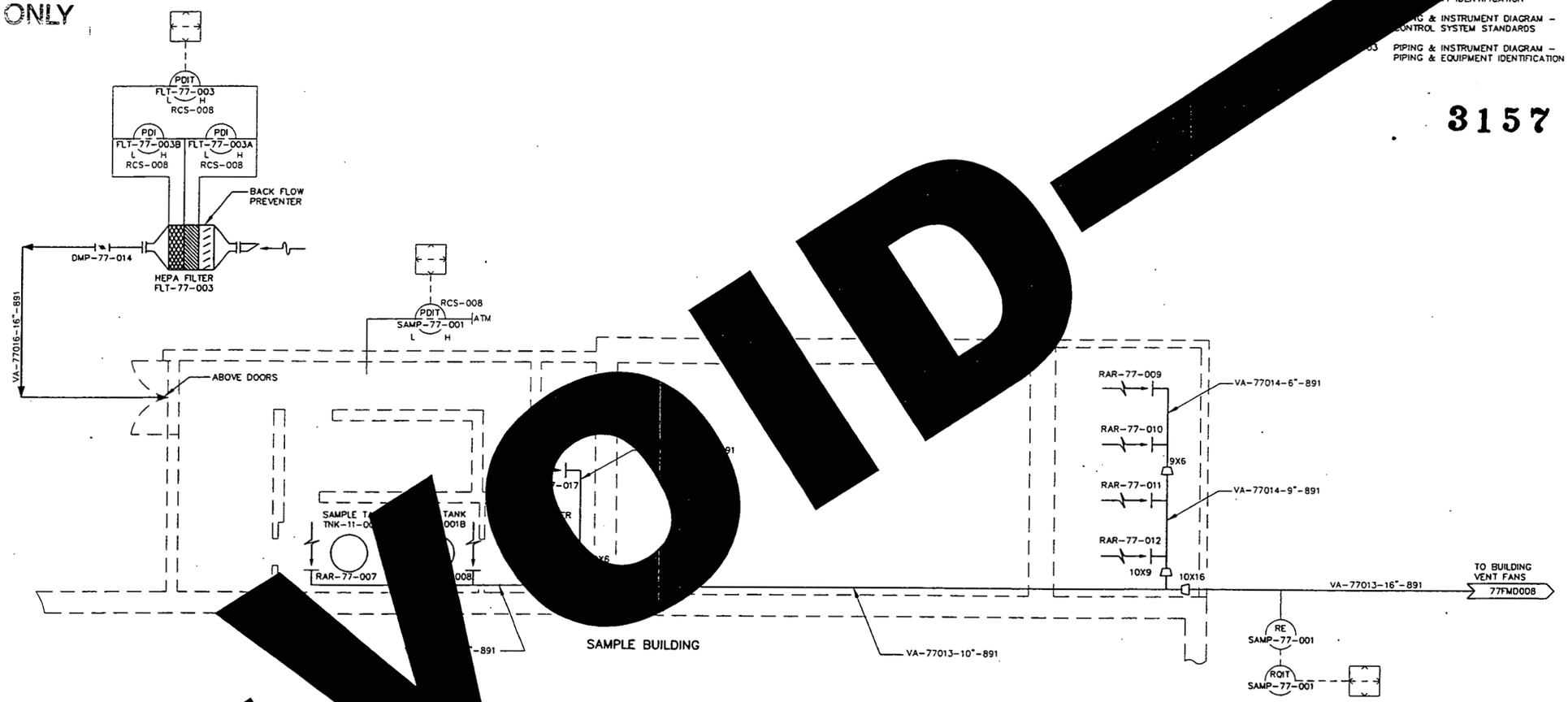
REFERENC

05D RUMENT DIAGRAM – IDENTIFICATION

G & INSTRUMENT DIAGRAM – CONTROL SYSTEM STANDARDS

03 PIPING & INSTRUMENT DIAGRAM – PIPING & EQUIPMENT IDENTIFICATION

3157



000364

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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A					PRELIMINARY DESIGN SUBMITTAL

PRELIMINARY
NOT FOR CONSTRUCTION

RPE

DRAWN BY BJD	DATE
DESIGNED BY BF	DATE
CHECKED BY	DATE
APPROVED BY	DATE
APPROVED BY	DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC CONTROL DIAGRAM
SAMPLE BUILDING VENTILATION

SIZE	SCALE:	DWG. NO.	REV
D	NONE	77FMD007	B

FILENAME: 77FMD007.DWG

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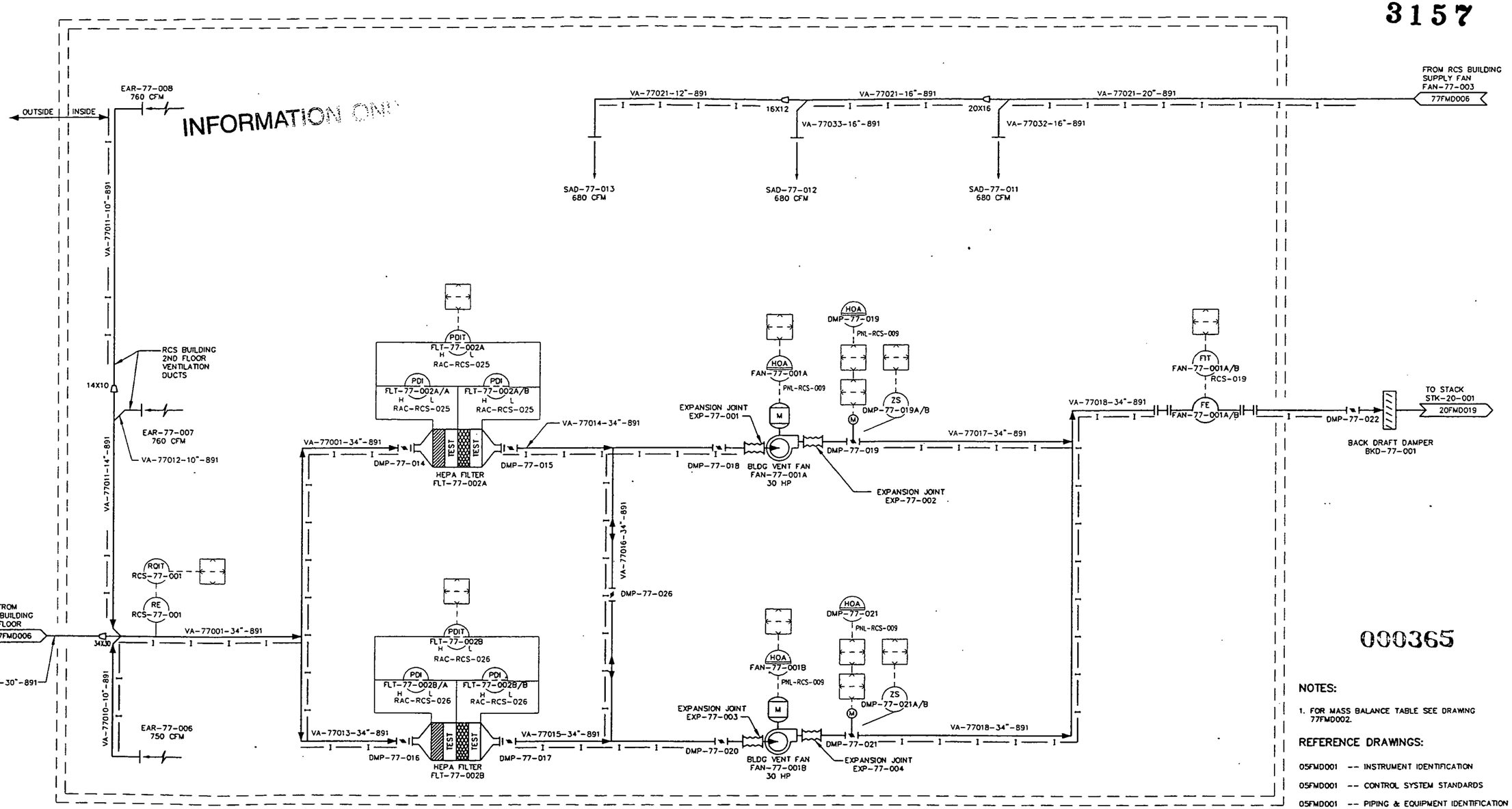

(94E) AIR HANDLING BUILDING – RCS
2ND FLOOR

000365

NOTES:

1. FOR MASS BALANCE TABLE SEE DRAWING 77FMD002.

REFERENCE DRAWINGS:

05FMD001 -- INSTRUMENT IDENTIFICATION
05FMD001 -- CONTROL SYSTEM STANDARDS
05FMD001 -- PIPING & EQUIPMENT IDENTIFICATION
05FMD001 -- GENERAL NOTES
05FMD001 -- VALVE LIST - SHEET 1
05FMD001 -- VALVE LIST - SHEET 2

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
B	05/15/00	BJO			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
A		BJO			PRELIMINARY DESIGN SUBMITTAL

RPE

		DATE
DRAWN BY	BJD	5-15-00
DESIGNED BY	BJD	5-15-00
CHECKED BY		
APPROVED BY		
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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC CONTROL DIAGRAM
RCS BLDG VENTILATION-2ND FL

SIZE D | SCALE: NONE | DWG. NO. 77FMD008 | REV B

FILENAME: 77FMD008.DWG

GENERAL ARRANGEMENT DRAWINGS

For information regarding General Arrangement Drawings, please see the following drawings:

DRAWING NUMBER	DRAWING TITLE	REVISION
05FMD010	MISC. FACILITIES GENERAL ARRANGEMENT KEY PLAN	3
10FMD017	FULL-SCALE MOCKUP SYSTEM GENERAL ARRANGEMENT SHEET 1 OF 2	2
10FMD018	FULL-SCALE MOCKUP SYSTEM SECTION SHEET 2 OF 2	2
11FMD019	SILO WASTE RETRIEVAL SYSTEM GENERAL ARRANGEMENT SILO 1 & 2 BRIDGE	2
11FMD020	SILO WASTE RETRIEVAL SYSTEM GENERAL ARRANGEMENT SILO 1 & 2 BRIDGE	2
11FMD025	SILO WASTE RETRIEVAL SYSTEM GENERAL ARRANGEMENT SAMPLE BUILDING	2
11FMD026	SILO WASTE RETRIEVAL SYSTEM SECTIONS & DETAILS SAMPLE BUILDING	2

GENERAL ARRANGEMENT DRAWINGS

DOCUMENT NO. 624-P622-12

INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
12FMD021	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 1 OF 6	2
12FMD022	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 2 OF 6	2
12FMD023	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 3 OF 6	1
12FMD024	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 4 OF 6	1
12FMD025	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 5 OF 6	1
12FMD026	TRANSFER TANK SYSTEM GENERAL ARRANGEMENT SHEET 6 OF 6	2
14FMD006	DECANT WASTE RETRIEVAL SYSTEM GENERAL ARRANGEMENT SHEET 1 0F 2	2
14FMD007	DECANT WASTE RETRIEVAL SYSTEM GENERAL ARRANGEMENT SHEET 2 0F 2	2

GENERAL ARRANGEMENT DRAWINGS

DOCUMENT NO. 624-P622-12

INFORMATION ONLY

DRAWING NUMBER	DRAWING TITLE	REVISION
20FMD027	RADON CONTROL SYSTEM GENERAL ARRANGEMENT 1st FLOOR	2
20FMD028	RADON CONTROL SYSTEM GENERAL ARRANGEMENT 2ND FLOOR	2
20FMD029	RADON CONTROL SYSTEM GENERAL ARRANGEMENT SECTIONS & DETAILS	2

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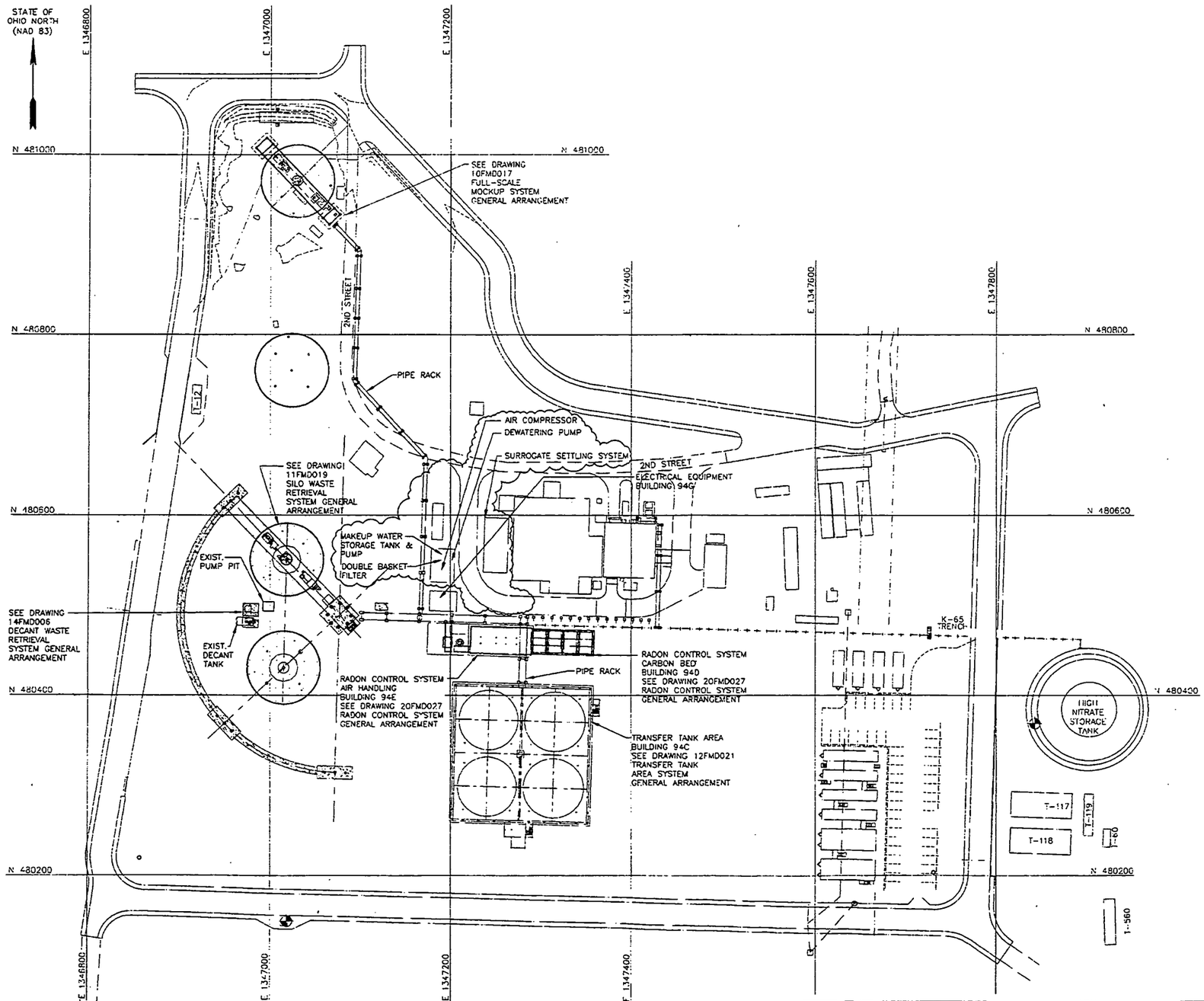

INFORMATION ONLY

UNCONTROLLED

000369

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
3					RELOCATED EQUIPMENT, DELETED EQUIPMENT AND ADDED EQUIPMENT
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

PPE

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES
GENERAL ARRANGEMENT
KEY PLAN

SIZE	SCALE:	DWG. NO.	REV
D	1"=60'-0"	05FMD010	3

FILENAME: 05FMD010.DWG

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XREF DRAWINGS:

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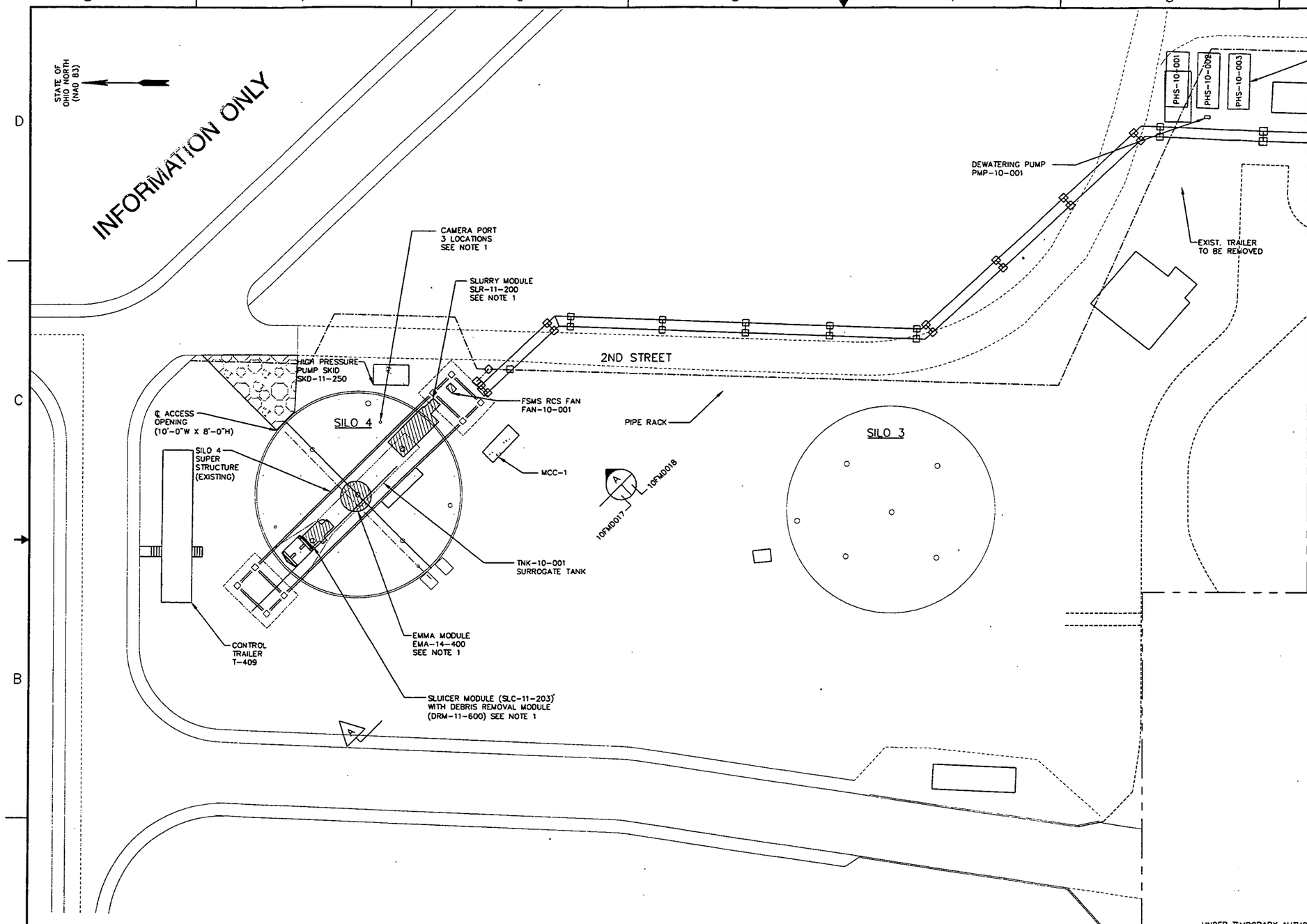

NOTES:

1. FOR RISER DETAILS, SEE SILO PENETRATION AND RISER INSTALLATION PLAN, DOCUMENT NO. 624-P622-63

REFERENCE DRAWINGS:

05FMD010 GENERAL ARRANGEMENT KEY PLAN

000370

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

LETTER OR NUMBER OF SECTION OR DETAIL

DRAWING ON WHICH SECTION OR DETAIL IS TAKEN

DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	RAR		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
GENERAL ARRANGEMENT
SHEET 1 OF 2

SIZE	SCALE:	DWG. NO.	REV
D	1"=20'-0"	10FMD017	2

XREF DRAWINGS: 05FMD010.DWG
60-PROP.DWG
60-EXIST.DWG

FILENAME: 10FMD017.

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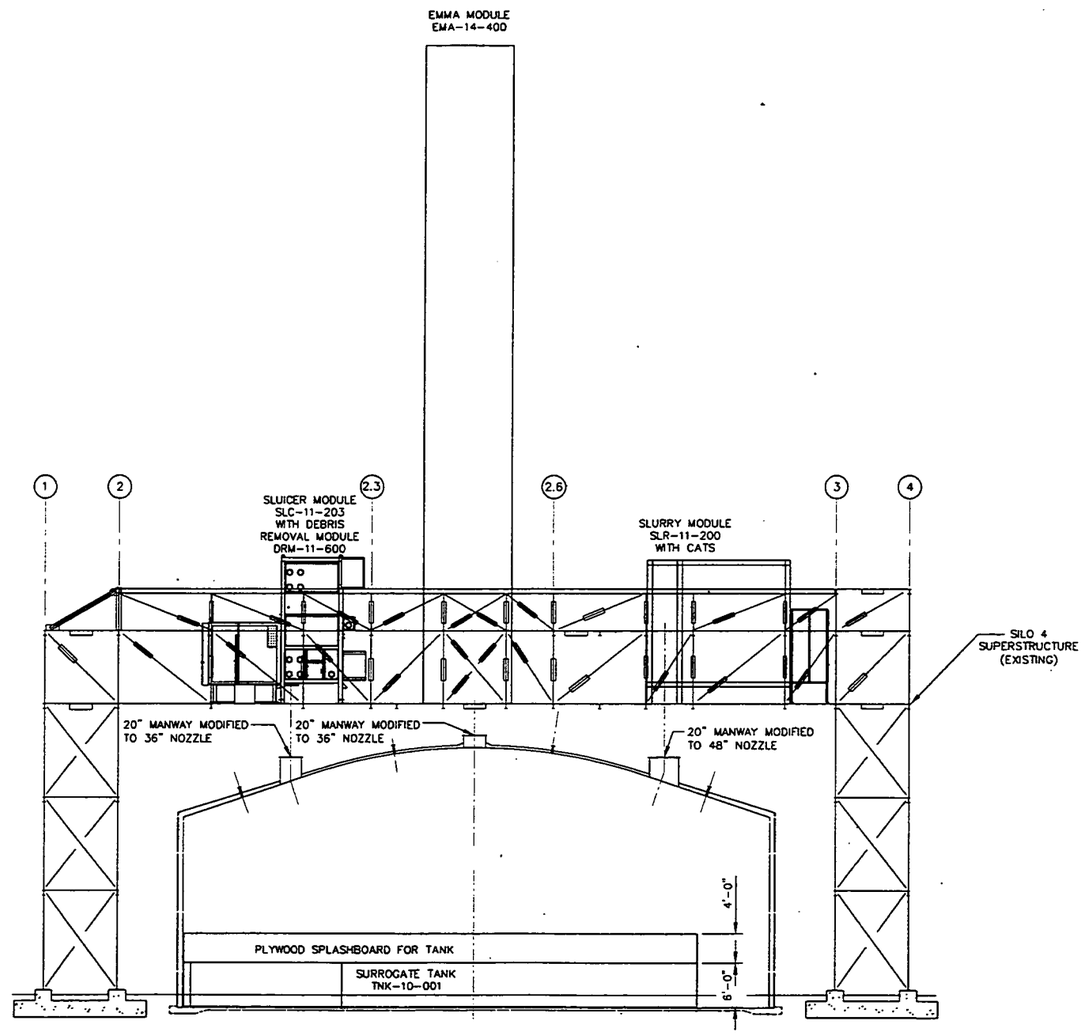
INFORMATION ONLY



A SECTION
SCALE: 1"=10'-0"
10FMD017 — 10FMD018

000371

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	RAR		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

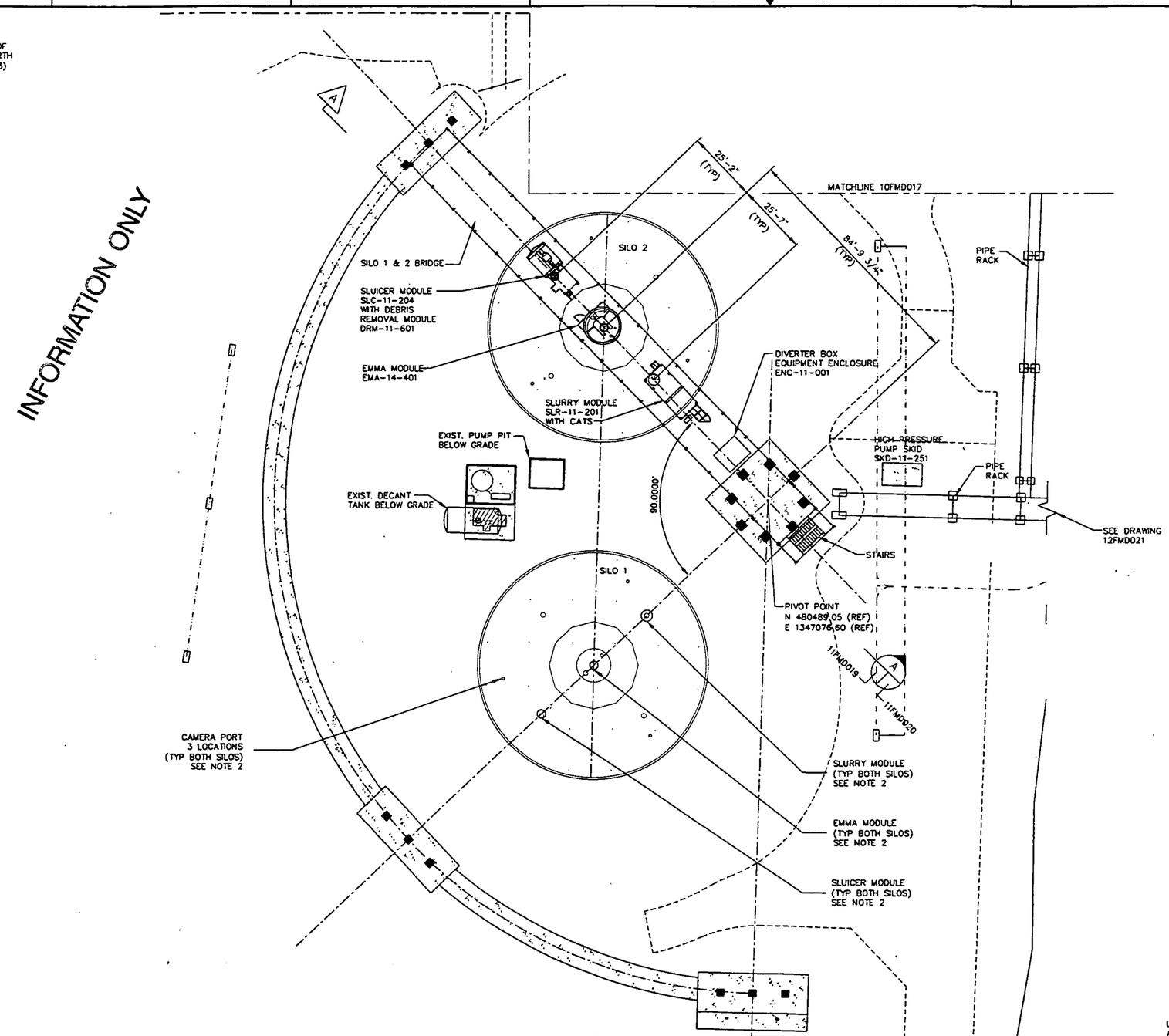
FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM
SECTION
SHEET 2 OF 2

SIZE	SCALE:	DWG. NO.	REV
D	1"=10'-0"	10FMD018	2

FILENAME: 10FMD018.

G:\CHARGE\FOS\MEC\SYS10\10fmd018.dwg Thu Jun 01 16:29:59 2000



PLAN (EL 607'-0")
SCALE: 1"=20'-0"

NOTES:

1. BRIDGE CRANE SHOWN IN SILO 2 OPERATION POSITION. SILO 1 IS SIMILAR.
2. FOR RISER DETAILS, SEE SILO PENETRATION AND RISER INSTALLATION PLAN, DOCUMENT NO. 624-P622-63

3157

REFERENCE DRAWINGS:

05FMD010 GENERAL ARRANGEMENT KEY PLAN

000372

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

DRAWN BY W C BLUME	DATE 01/07/00	
DESIGNED BY W C BLUME	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
GENERAL ARRANGEMENT
SILO 1 & 2 BRIDGE

SIZE	SCALE:	DWG. NO.	REV
D	1"=20'-0"	11FMD019	2

XREF DRAWINGS: 10FMD010.DWG 09-PROP.DWG 09-EXIST.DWG

FILENAME: 11FMD019.

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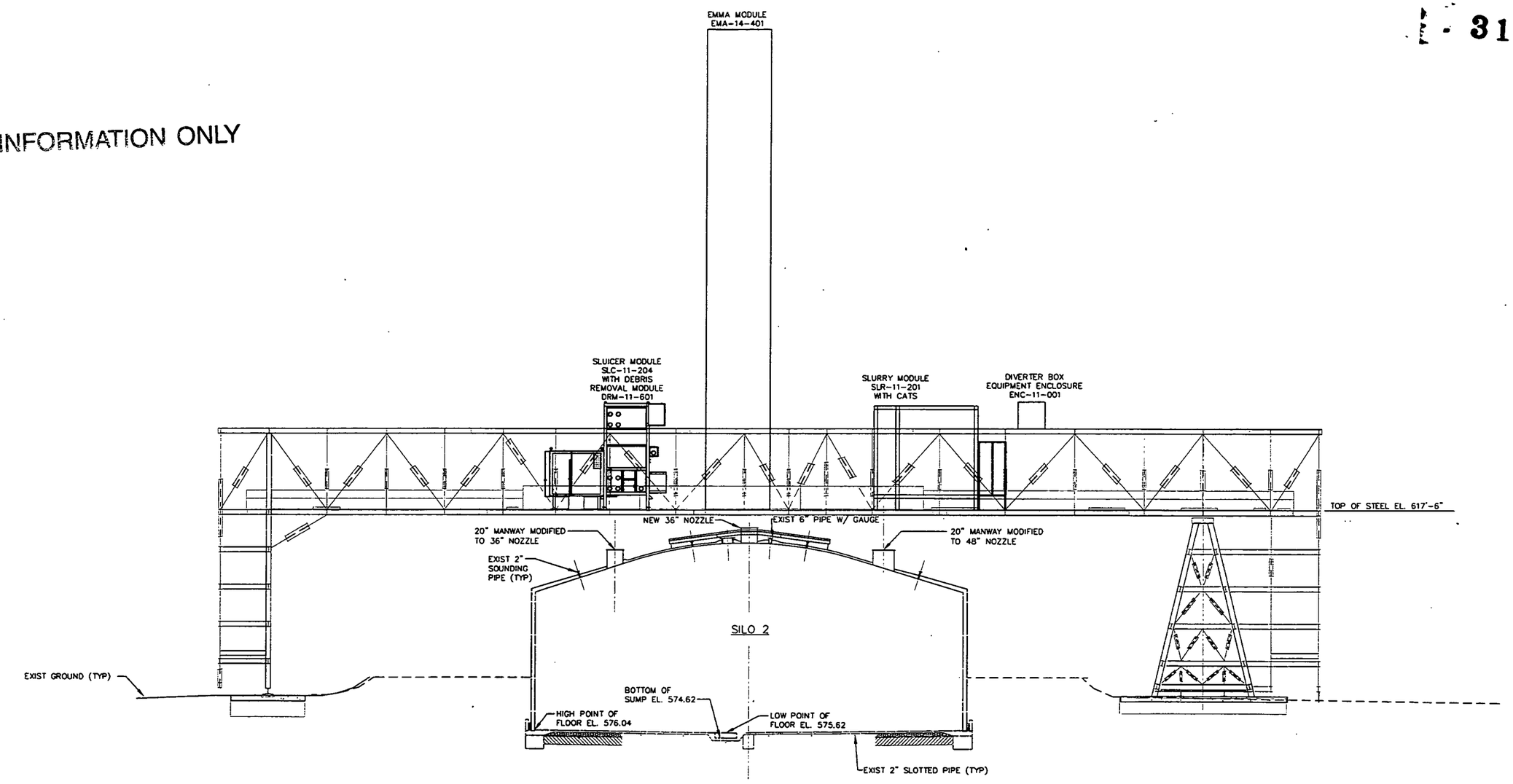
INFORMATION ONLY



A SECTION
SCALE: 1"=10'-0"
11FMD019 11FMD020

000373

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

LETTER OR NUMBER OF SECTION OR DETAIL
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DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
GENERAL ARRANGEMENT
SILO 1 & 2 BRIDGE

SIZE D | SCALE: 1"=10'-0" | DWG. NO. 11FMD020 | REV 2

FILENAME: 11FMD020.D

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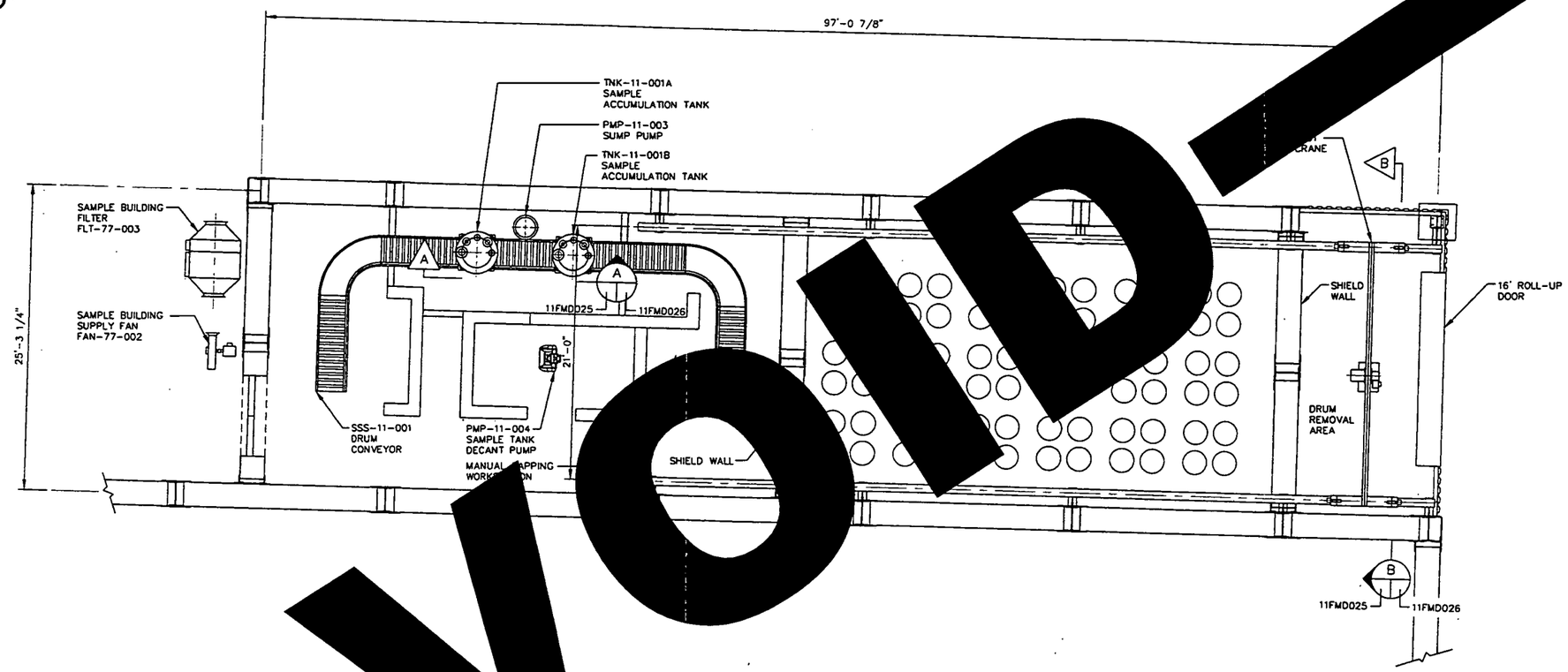
3157

VOID

INFORMATION ONLY

STATE OF OHIO NORTH (NAD 83)



PLAN VIEW
SCALE: 3/16"=1'-0"

000374

REFERENCE DRAWINGS:

05FMD010 GENERAL ARRANGEMENT KEY PLAN

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

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SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					DRAWING VOIDED
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE

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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
GENERAL ARRANGEMENT
SAMPLE BUILDING

SIZE	SCALE:	DWG. NO.	REV
D	3/16" = 1'-0"	11FMD025	2

FILENAME: 11FMD025

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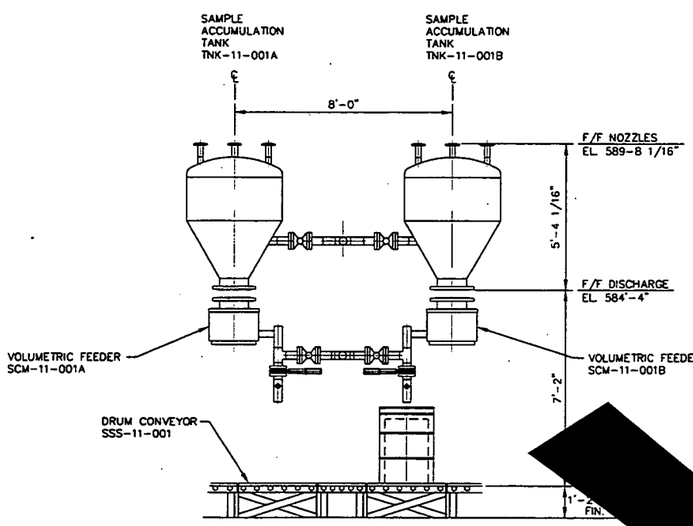
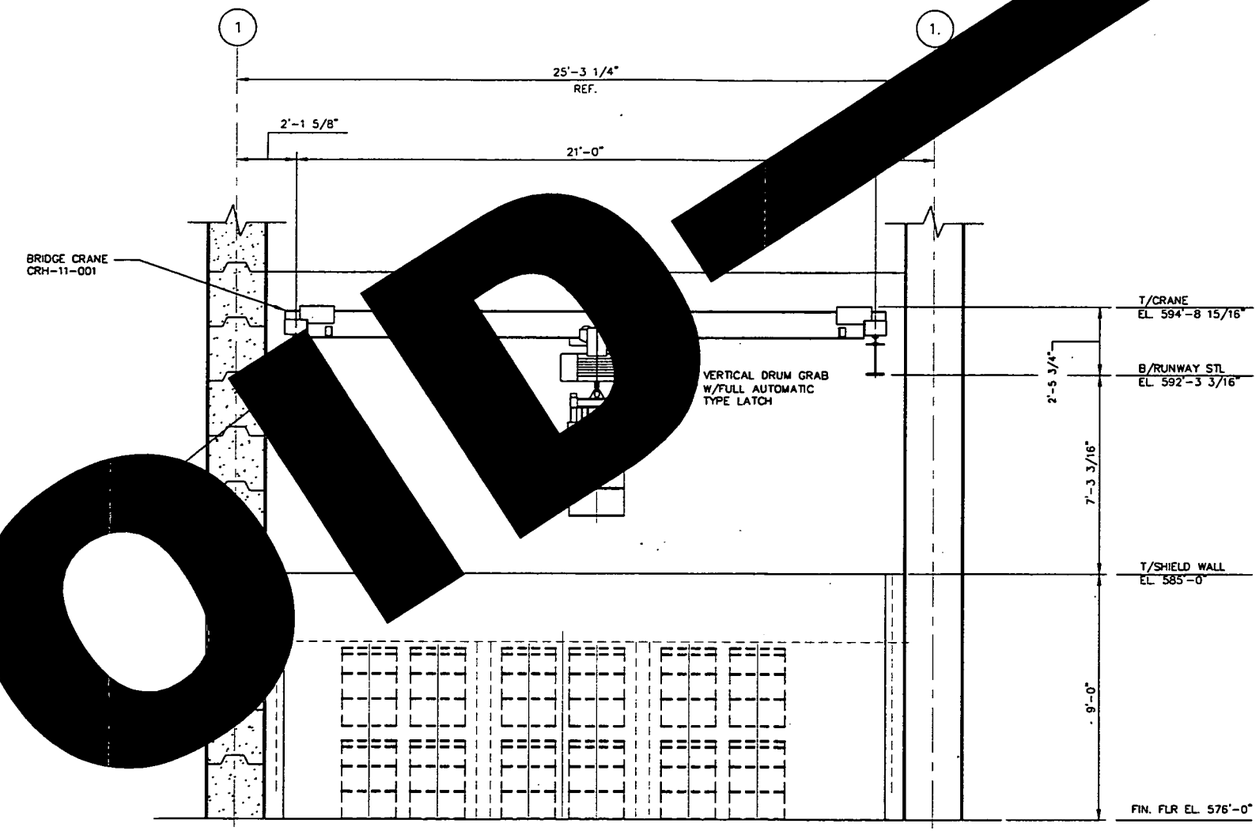
INFORMATION ONLY

VOID



A SECTION
SCALE: 3/8" = 1'-0"
11FMD025 — 11FMD026



B SECTION
SCALE: 3/8" = 1'-0"
11FMD025 — 11FMD026

000375

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

LETTER OR NUMBER OF SECTION OR DETAIL
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SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					DRAWING VOIDED
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE

		DATE
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DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
SECTIONS & DETAILS
SAMPLE BUILDING

SIZE: D | SCALE: 3/8" = 1'-0" | DWG. NO. 11FMD026 | REV 2

FILENAME: 11FMD026

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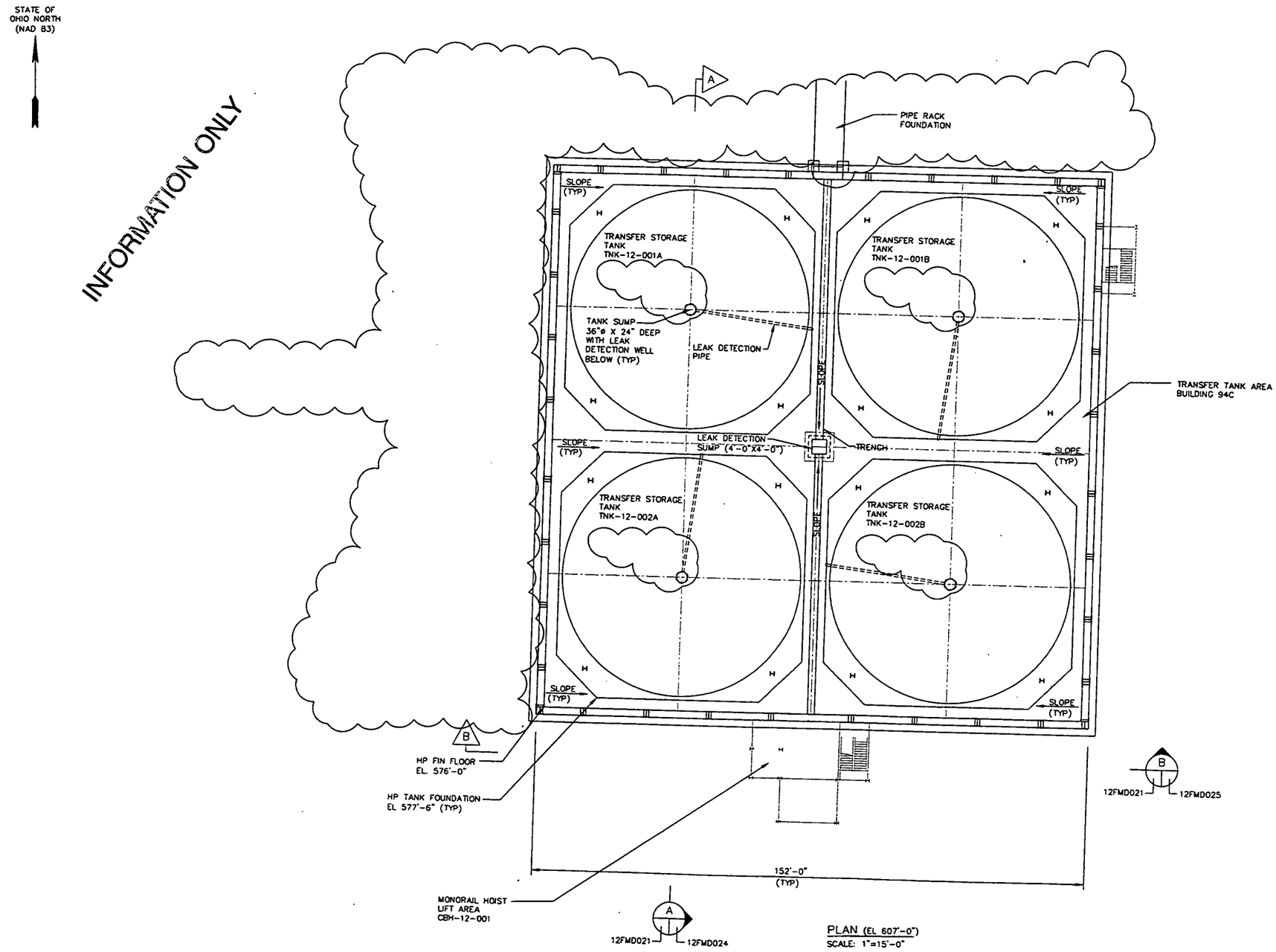

PLAN (EL 607'-0")
SCALE: 1"=15'-0"

NOTES:

1. RATE OF FLOOR SLOPE IS 1"/8'-0" UNLESS NOTED OTHERWISE.

3157

REFERENCE DRAWINGS:

05FMD010 GENERAL ARRANGEMENT KEYPLAN

000376

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE

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APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 1 OF 6

SIZE	SCALE:	DWG. NO.	REV
D	1"=15'-0"	12FMD021	2

FILENAME: 12FMD021.

XREF DRAWINGS: 10FMD010.DWG

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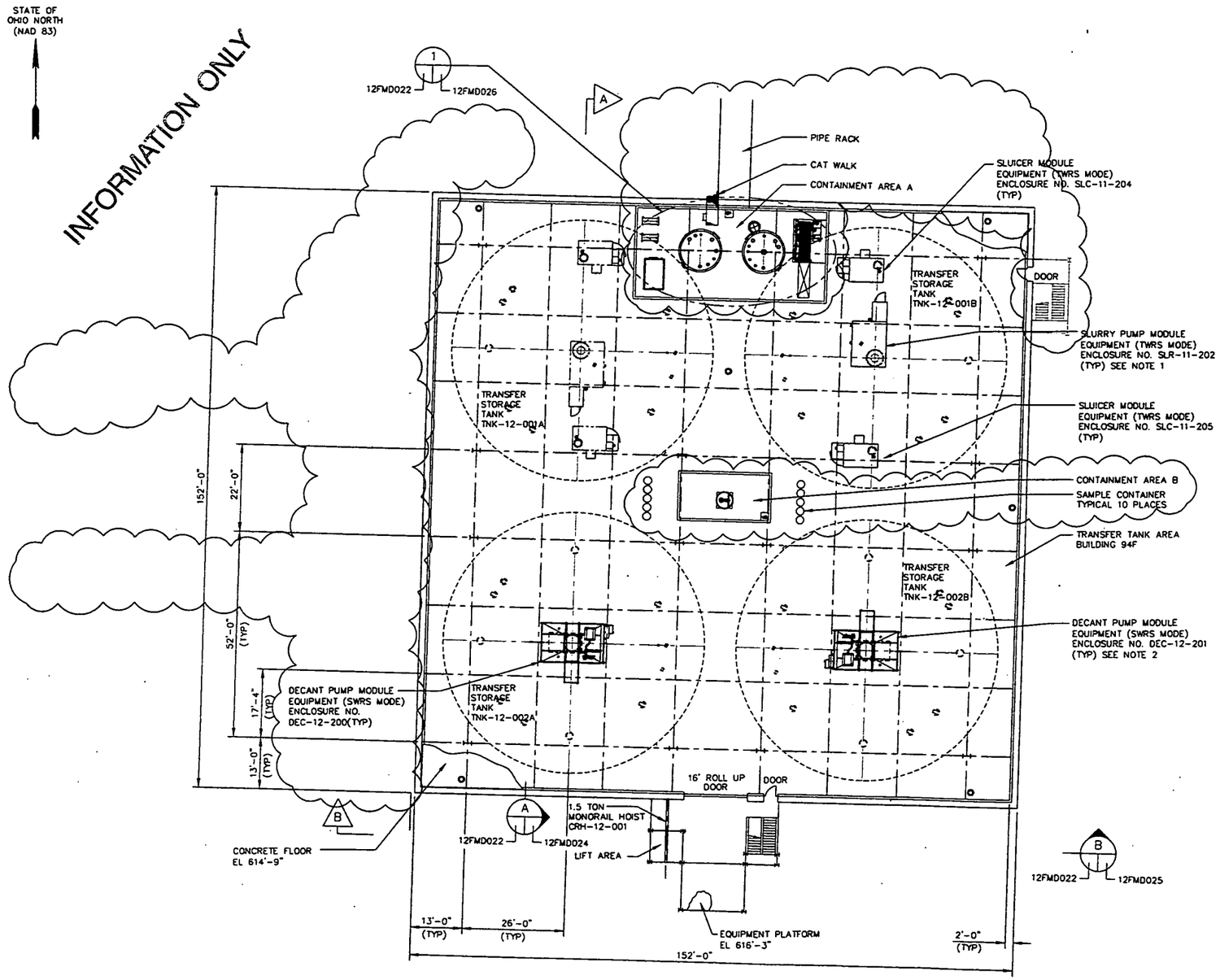

NOTES:

1. TANK TNK-12-001B IS SHOWN WITH TWRS MODE EQUIPMENT IN PLACE. THIS SAME EQUIPMENT WILL MOVE FROM TANK TO TANK. THE EQUIPMENT SHOWN ON TANK TNK-12-001A IS FOR ORIENTATION PURPOSES ONLY.
2. TANK TNK-12-002A & 002B REFLECTS EQUIPMENT REQUIRED FOR SWRS MODE. THE DECANT MODULES WILL BE MOVED AS REQUIRED.

3157

000377

PLAN (EL 638'-0")
SCALE: 1"=15'-0"

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SECTION & DETAIL KEY

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

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1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPC

DRAWN BY	W C BLUME	01/07/00
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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 2 OF 6

SIZE D | SCALE: 1"=15'-0" | DWG. NO. 12FMD022 | REV 2

FILENAME: 12FMD022.D

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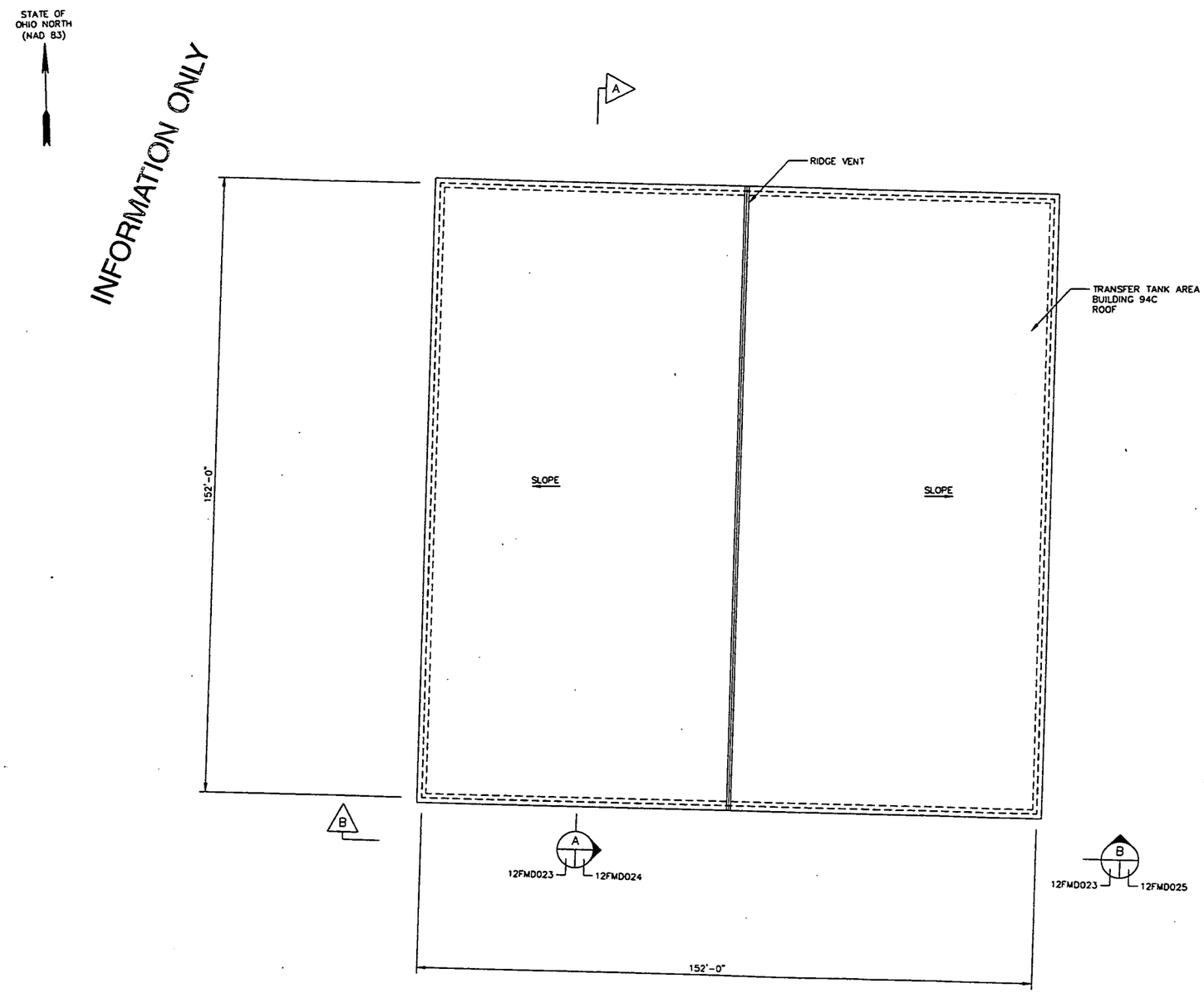
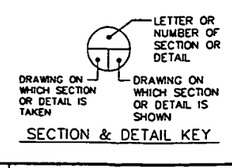


PLAN (EL 650'-0")
SCALE: 1"=15'-0"

000378



SECTION & DETAIL KEY

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 1

DRAWN BY W C BLUME	DATE 01/07/00	
DESIGNED BY W C BLUME	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 3 OF 6

SIZE	SCALE:	DWG. NO.	REV
D	1"=15'-0"	12FMD023	1

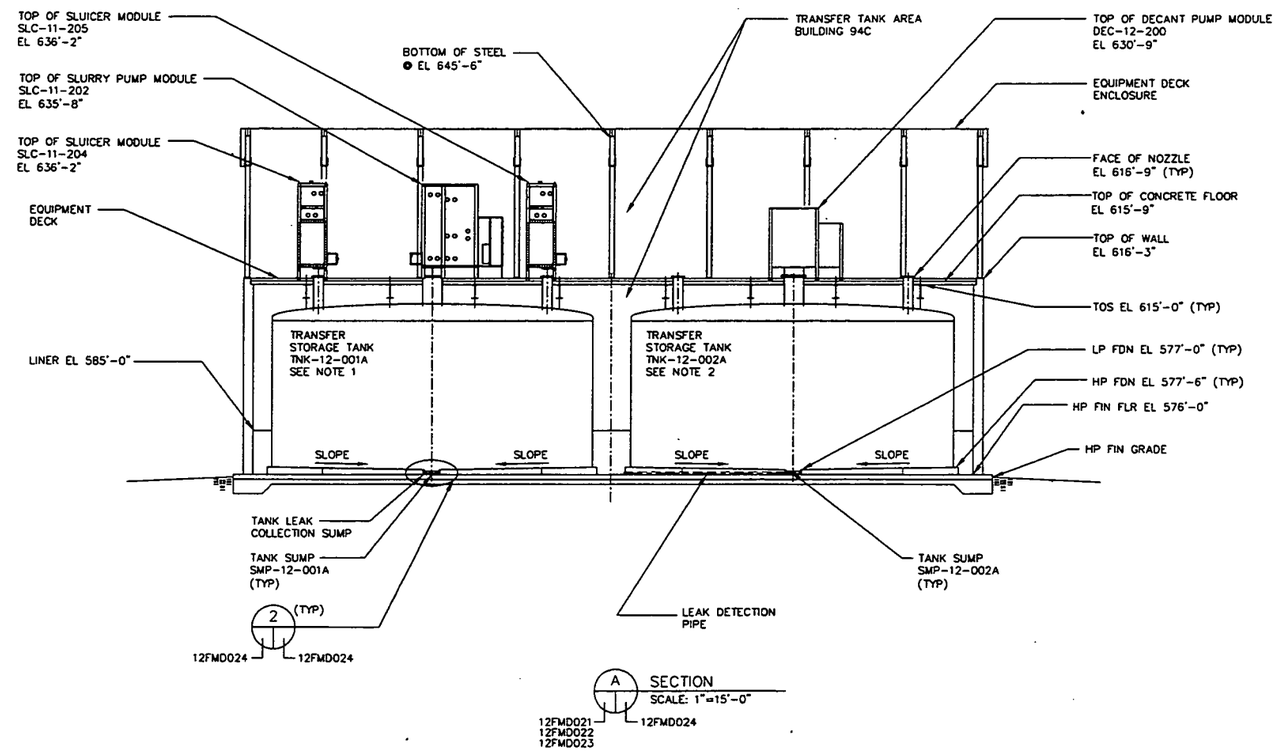
FILENAME: 12FMD023.D

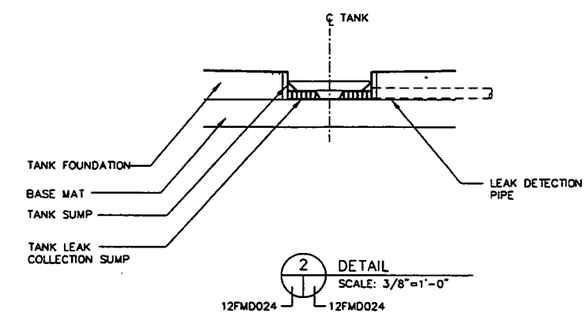
G:\CHARGE\R...DS\MEC\SYS12\12fmd023.dwg Thu Jun 01 15:57:39 2000

INFORMATION ONLY

NOTES:
1. TNK-12-001A IS SHOWN IN TWRS MODE.
2. TNK-12-002A IS SHOWN IN SWRS MODE.

3157





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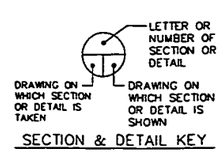

SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	11/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 1

DRAWN BY	W C BLUME	DATE 01/07/00
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CHECKED BY	S W HUNGATE	DATE 01/07/00
APPROVED BY	KENNETH RICKETT	DATE 01/07/00
APPROVED BY	JOHN LAWSON	DATE 01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 4 OF 6

SIZE	SCALE:	DWG. NO.	REV
D	1"=15'-0"	12FMD024	1

FILENAME: 12FMD024.

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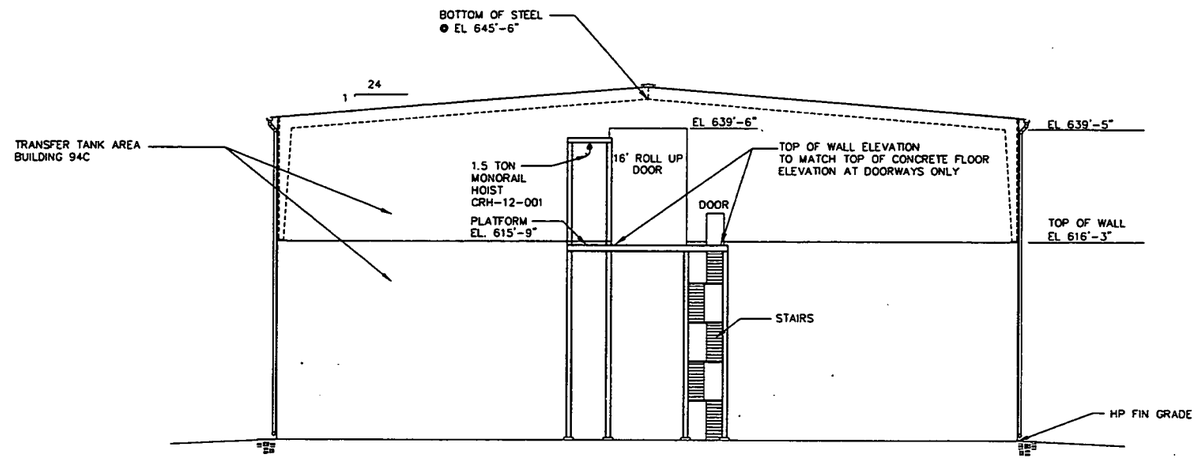
INFORMATION ONLY



B SECTION
SCALE: 1"=15'-0"
12FMD021
12FMD022
12FMD023
12FMD025

000380

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

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0	11/01/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 1

		DATE
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DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 5 OF 6

SIZE	SCALE:	DWG. NO.	REV
D	1"=15'-0"	12FMD025	1

FILENAME: 12FMD025.

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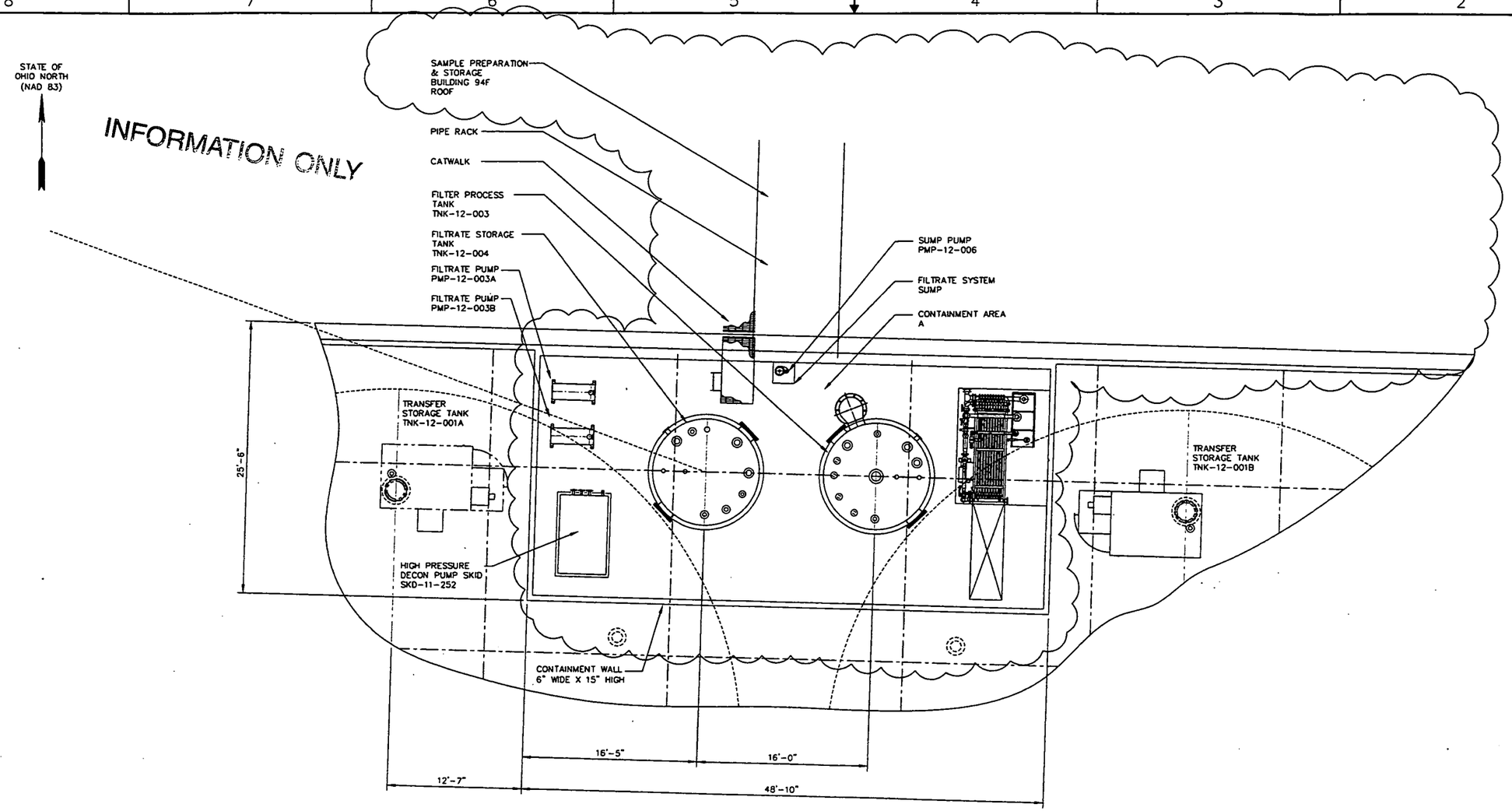

PARTIAL PLAN VIEW-EQUIPMENT DECK

ULTRA FILTRATION SYSTEM AND FILTRATE STORAGE AREA

1 DETAIL
SCALE: 3/16"=1'-0"
12FMD022 — 12FMD026

000381

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

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RPE

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CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
TRANSFER TANK SYSTEM
GENERAL ARRANGEMENT
SHEET 6 OF 6

SIZE D | SCALE: 3/16" = 1'-0" | DWG. NO. 12FMD026 | REV 2

FILENAME: 12FMD026.D

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NOTES:

1. BRIDGE CRANE SHOWN IN SILO 2 OPERATION POSITION. SILO 1 IS SIMILAR.

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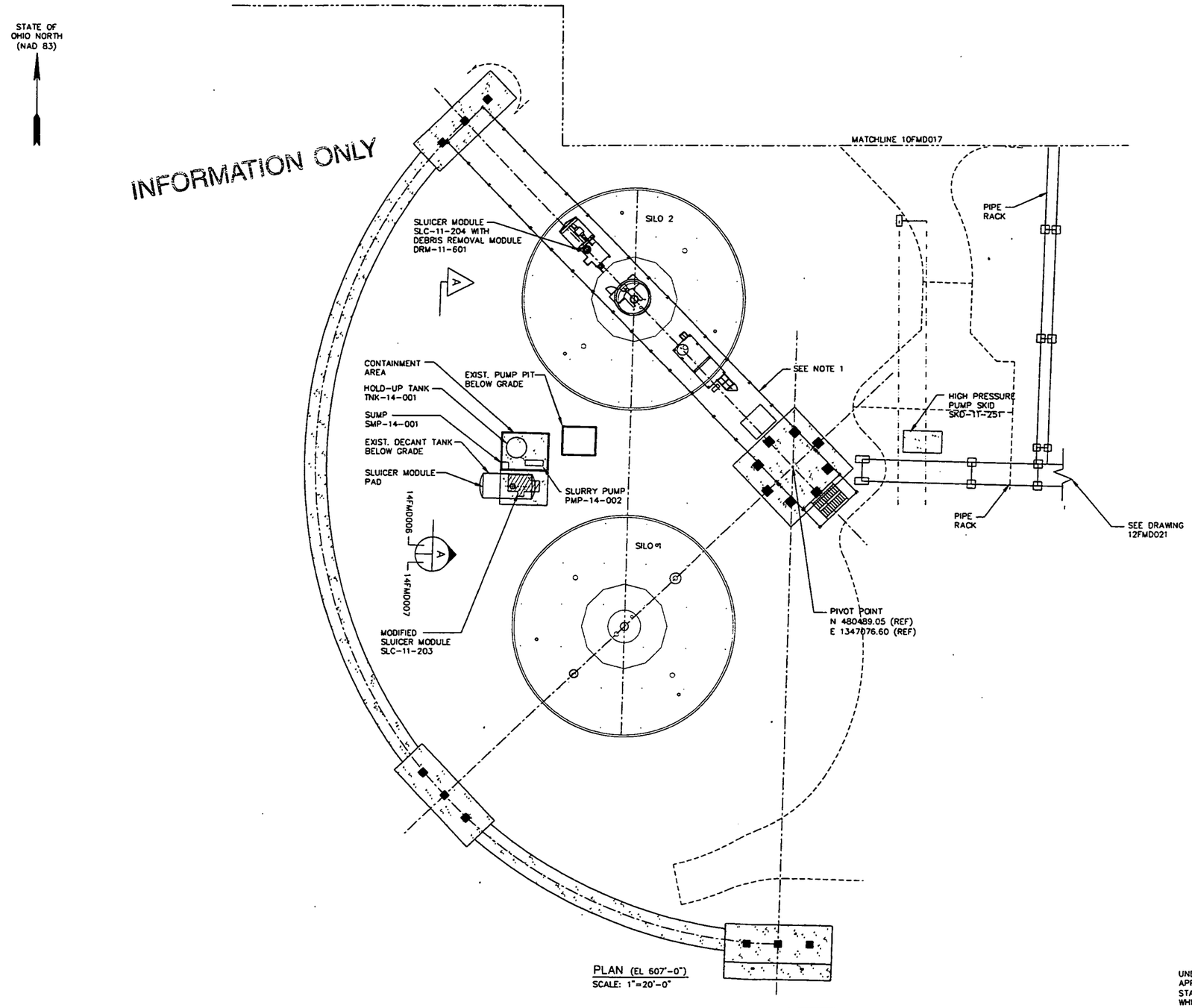

PLAN (EL 607'-0")
SCALE: 1"=20'-0"

REFERENCE DRAWINGS:

05FMD010 GENERAL ARRANGEMENT KEY PLAN

000382

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

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0	11/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

		DATE
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CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
DECANT WASTE RETRIEVAL SYSTEM
GENERAL ARRANGEMENT
SHEET 1 OF 2

SIZE	SCALE:	DWG. NO.	REV
D	1"=20'-0"	14FMD006	2

FILENAME: 14FMD006.

XREF DRAWINGS: 10FMD010.DWG 60-PROP.DWG 60-EXIST.DWG

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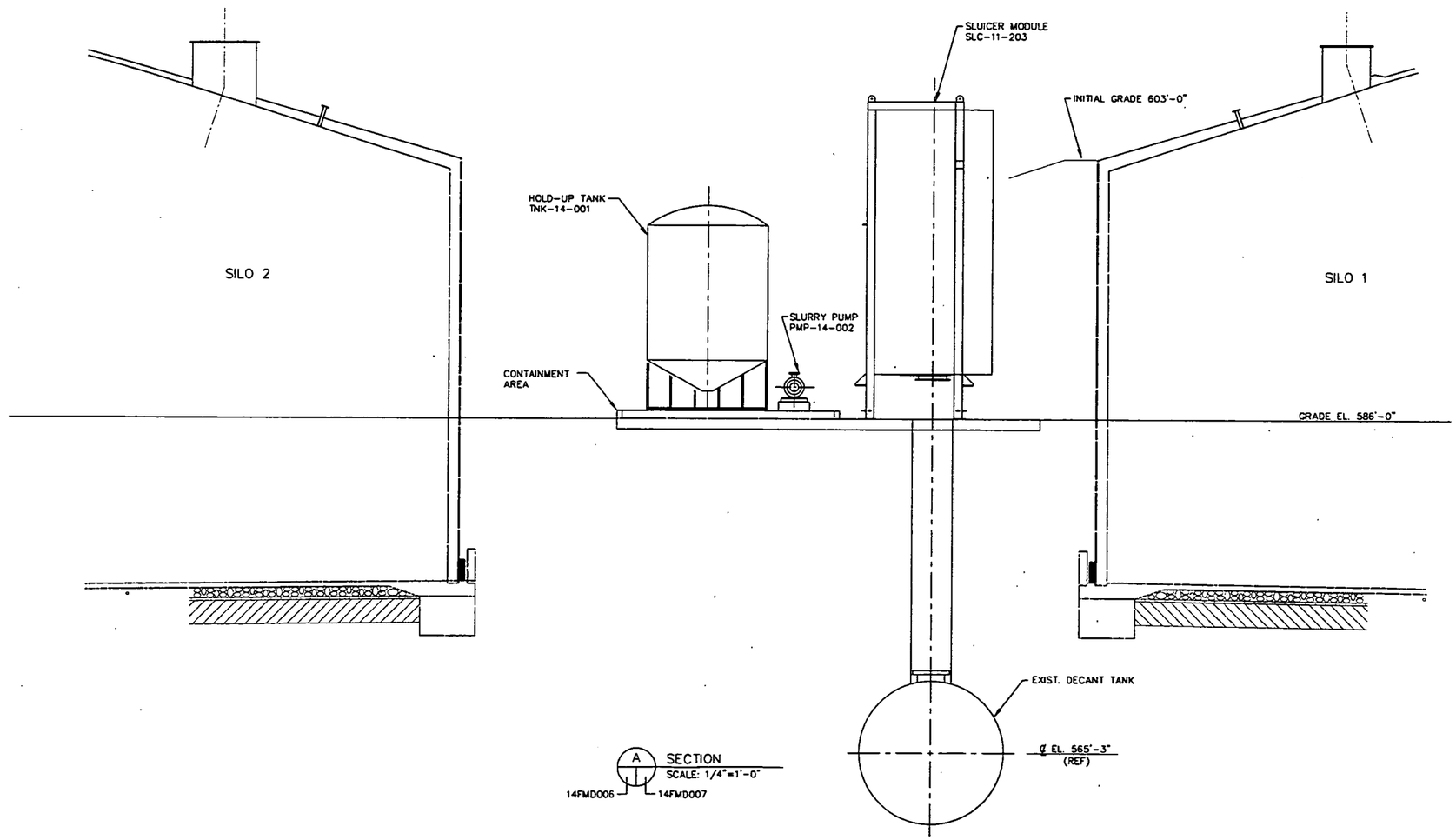
INFORMATION ONLY



000383

UNDER TEMPORARY AUTHORIZATION (BASED ON APPLICATION TO REGISTER BY COMITY IN THE STATE OF OHIO, DATED DECEMBER 6, 1999) WHICH WILL EXPIRE ON MARCH 31, 2000.

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
1	12/01/99	WCB	SWH		REVISED FOR NOZZLE LOCATIONS
0	11/99	WCB	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. 103742
01/07/00
REVISION 2

DRAWN BY W C BLUME	DATE 01/07/00	
DESIGNED BY W C BLUME	DATE 01/07/00	
CHECKED BY S W HUNGATE	DATE 01/07/00	
APPROVED BY KENNETH RICKETT	DATE 01/07/00	
APPROVED BY JOHN LAWSON	DATE 01/07/00	

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
DECANT WASTE RETRIEVAL SYSTEM
GENERAL ARRANGEMENT
SHEET 2 OF 2

SIZE	SCALE:	DWG. NO.	REV
D	1/4" = 1'-0"	14FMD007	2

FILENAME: 14fmd007.D

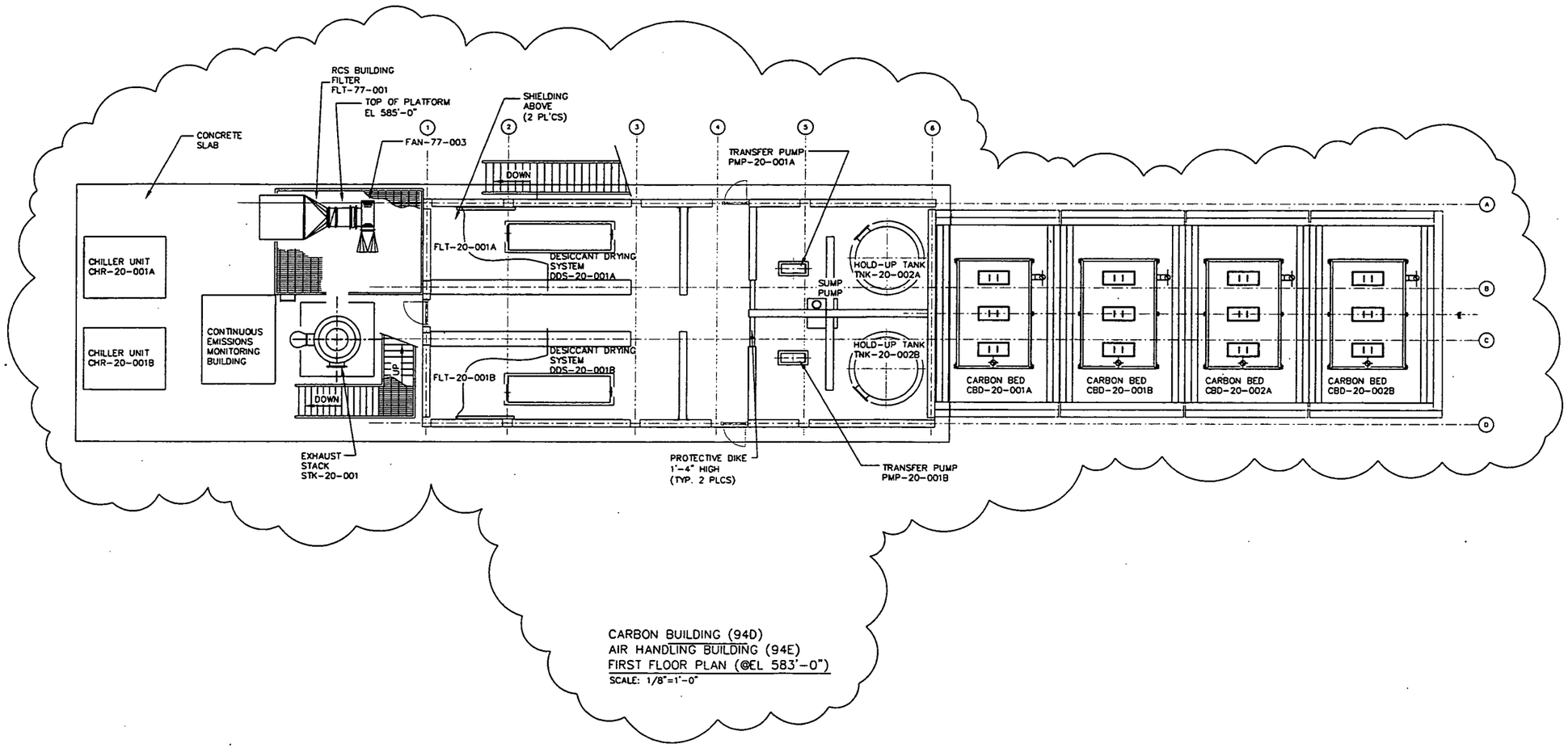
G:\CHARGE\FD\S\MEC\SYS14\14fmd007.dwg Thu Jun 01 16:36:02 2000

NOTES:
1. FOR CLARITY SYSTEM 20 RCS AND SYSTEM 77 MISCELLANEOUS HVAC FACILITIES HVAC SYSTEM ARE PRESENTED ON SYSTEM 20 DRAWINGS.

3157

INFORMATION ONLY

STATE OF OHIO NORTH (NAD 83)



CARBON BUILDING (94D)
AIR HANDLING BUILDING (94E)
FIRST FLOOR PLAN (@EL 583'-0")
SCALE: 1/8"=1'-0"

000384

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	JG	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-004
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	MBF		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

TITLE
RADON CONTROL SYSTEM
GENERAL ARRANGEMENT
1ST FLOOR

SIZE D | SCALE: 1/8"=1'-0" | DWG. NO. 20FMD027 | REV 2

FILENAME: 20FMD027.

G:\CHARGE\PROJS\MEC\SYS20\20fmd027.dwg Thu Jun 01 16:36:59 2000

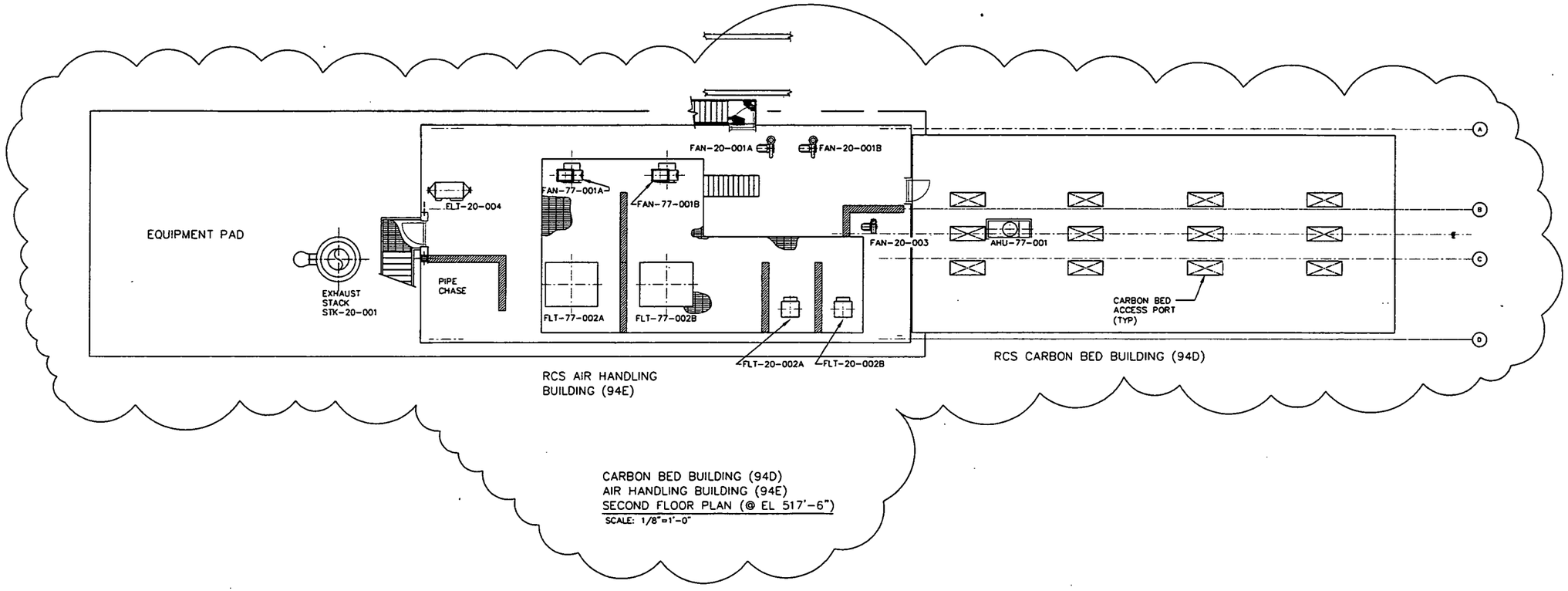
NOTES:

1. FOR CLARITY SYSTEM 20 RCS AND SYSTEM 77 MISCELLANEOUS HVAC FACILITIES HVAC SYSTEM ARE PRESENTED ON SYSTEM 20 DRAWINGS.

3157

STATE OF OHIO NORTH (NAD 83)

INFORMATION ONLY



CARBON BED BUILDING (94D)
AIR HANDLING BUILDING (94E)
SECOND FLOOR PLAN (@ EL 517'-6")
SCALE: 1/8"=1'-0"

000385

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	JG	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-004
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	MBF		PRELIMINARY DESIGN SUBMITTAL

RPE
KENNETH D. RICKETT
P.E. NO. E-64418
5/15/00
REVISION 2

		DATE
DRAWN BY	W C BLUME	01/07/00
DESIGNED BY	W C BLUME	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
GENERAL ARRANGEMENT
2ND FLOOR

SIZE	SCALE:	DWG. NO.	REV
D	1/8"=1'-0"	20FMD028	2

FILENAME: 20FMD028.

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INFORMATION ONLY

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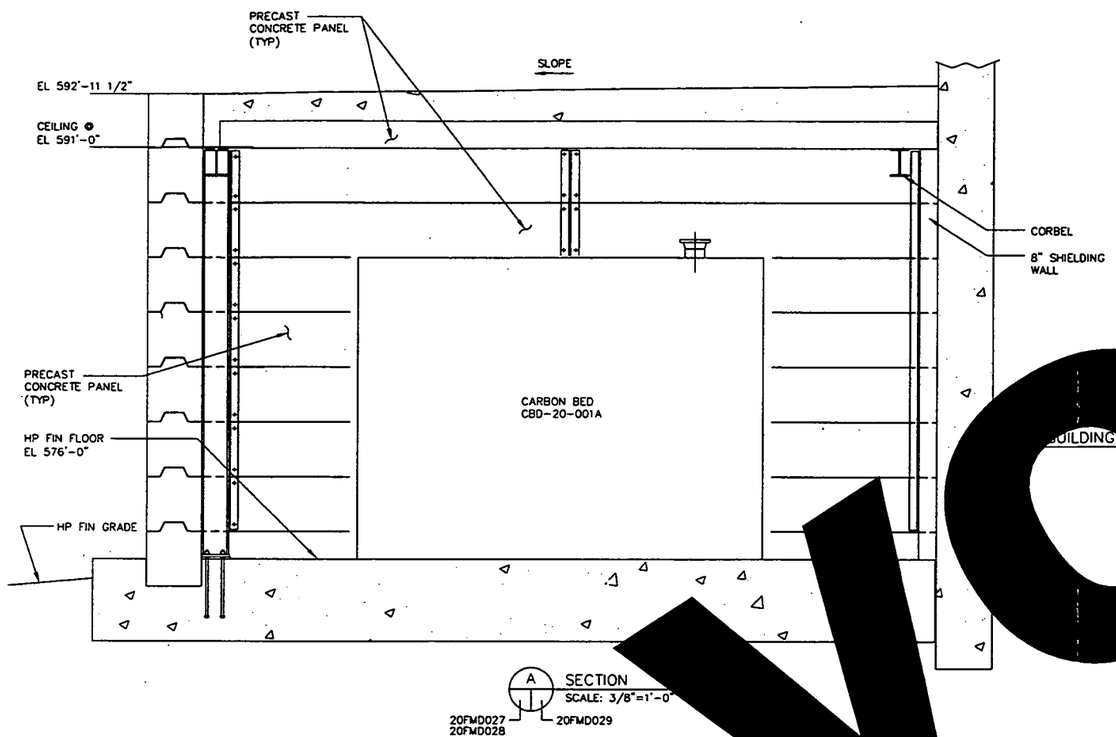

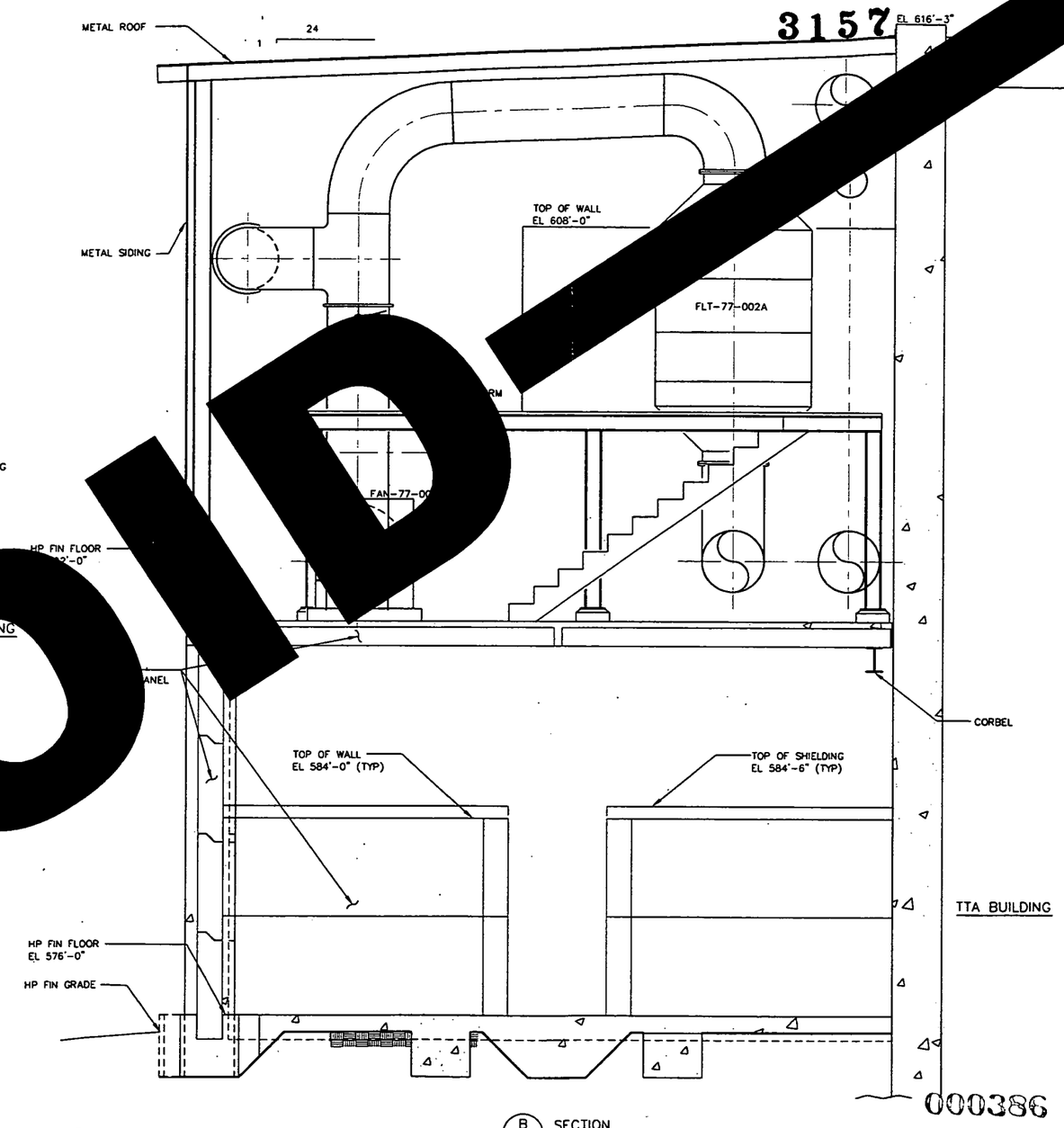

000386

NOTES:

1. FOR CLARITY SYSTEM 20 RCS AND SYSTEM 77 MISCELLANEOUS HVAC FACILITIES HVAC SYSTEM ARE PRESENTED ON SYSTEM 20 DRAWINGS.

DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	JG	GCH	KDR	DRAWING VOIDED
1	01/07/00	WCB	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	WCB	MBF		PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY W C BLUME	DATE 01/07/00
DESIGNED BY W C BLUME	DATE 01/07/00
CHECKED BY S W HUNGATE	DATE 01/07/00
APPROVED BY KENNETH RICKETT	DATE 01/07/00
APPROVED BY JOHN LAWSON	DATE 01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
RADON CONTROL SYSTEM
GENERAL ARRANGEMENT
SECTIONS & DETAILS

SIZE	SCALE:	DWG. NO.	REV
D	3/8"=1'-0"	20FMD029	2

FILENAME: 20FMD029.D

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INFORMATION ONLY

3157

PHASE 1 (SEE NOTE 2)

STREAM NUMBER	1	2	3	4	5	6	7	8	9
COMPONENT	AIR FROM SILO 4	AIR TO SILO 4	AIR TO STACK	FAN RECYCLE FLOW	AIR TO FAN	MAKE-UP AIR	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOUSRE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INLFLOW
AIR (LBS/HR)	2,166	2,166	216.6	1,949.4	4,332	--	--	--	--
WATER (LBS/HR)	40.6	40.6	4.1	36.5	81.2	--	--	--	--
TOTAL (LBS/HR)	2,206.6	2,206.6	220.7	1,985.9	4,413.2	--	--	--	--
FLOW (CFM)	500	500	50	450	1,000	50	--	--	--
FLOW (GPM)	--	--	--	--	--	--	--	--	--
RADON (PICOCURIES/L)	--	--	--	--	--	--	--	--	--
RADON (CURIES/HR)	--	--	--	--	--	--	--	--	--
TEMPERATURE (DEG F)	75	75	75	75	75	--	--	--	--
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--
NOTES									

PHASE 2 (SEE NOTE 3)

STREAM NUMBER	1	2	3	4	5	6	7	8	9
COMPONENT	AIR FROM SILO 4	AIR TO SILO 4	AIR TO STACK	FAN RECYCLE FLOW	AIR TO FAN	MAKE-UP AIR	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	1,083	--	3,249	1,083	4,332	2,166	361	361	361
WATER (LBS/HR)	20.3	--	60.9	20.3	81.2	40.6	6.8	6.8	6.8
TOTAL (LBS/HR)	1,103.3	--	3,309.9	1,103.3	4,413.2	2,206.6	367.8	367.8	367.8
FLOW (CFM)	250	--	750	250	1,000	500	83	83	83
FLOW (GPM)	--	--	--	--	--	--	--	--	--
RADON (PICOCURIES/L)	--	--	--	--	--	--	--	--	--
RADON (CURIES/HR)	--	--	--	--	--	--	--	--	--
TEMPERATURE (DEG F)	75	--	75	75	75	75	75	75	75
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--
NOTES									

NOTES:

1. MASS BALANCE TABLES TO BE USED IN CONJUNCTION WITH 10FMD002, & 10FMD003.
2. PHASE 1 MASS BALANCE REPRESENTS RCS RECYCLE WITH 100% OF AIR PULLED FROM SILO 4 RECYCLED BACK TO SILO 4.
3. PHASE 2 MASS BALANCE REPRESENTS RCS OPERATION DURING RETRIEVAL MODE FROM SILOS AND AIRFLOW THROUGH EQUIPMENT MODULES.

000387

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	RAR		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE

FULL-SCALE MOCKUP SYSTEM
PROCESS FLOW DIAGRAM
MASS BALANCE-RADON CONTROL

SIZE	SCALE:	DWG. NO.	REV
D	NONE	10FMD001	2

FILENAME: 10FMD001.DWG

10FMD001.dwg, 05/26/2000 02:32:41 PM

INFORMATION ONLY

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FULL-SCALE MOCKUP MASS BALANCE TABLE

FSMS INVENTORY		STREAM NUMBER	37	1	1	2	3	4	30	5	6	7	7	7	21	22	8	28	29	9
		STREAM DESCRIPTION	DECANT FROM TTA TO UF MAKE-UP CONNECTION	DECANT FROM UF MAKE-UP CONNECTION (BULK RETRIEVAL)	DECANT FROM UF MAKE-UP CONNECTION (CATS)	DECANT DILUTION WATER	DECANT FLUSH WATER	DECANT WATER TO BE FILTERED	DECANT MAKE-UP TO FILTER PROCESS TANK			SLURRY DISCHARGE (BULK RETRIEVAL)	SLURRY DISCHARGE RETRIEVED WASTE (BULK RETRIEVAL)	SLURRY DISCHARGE (CATS WITH DILUTION WATER)	SLURRY DISCHARGE (FROM SREE TO SLURRY PUMP)		SLURRY LINE FROM UF SYSTEM	UF SUPPLY FROM PROCESS TANK	UF RETURN TO PROCESS TANK	
TOTAL SOLIDS (LB)	184,751		NOTE 3					NOTE 3	NOTE 3				NOTE 2				NOTE 3	NOTE 3	NOTE 3	
BENTOGROUT (LB)	3,791	FLOW (GPM)	320	300	300	50	300	320	20			355	355	325	25		300	300	100	
FIU SIMULANT (LB)	180,960	% SOLIDS (WT)	0	0	0	0	0	0	0			15.0	15.0	3.0	32		0	0	0	
VOLUME BENTOGROUT (GAL) IN-SITU	1,575	SOLIDS PER GAL (LB)	0	0	0	0	0	0	0			1.334	1.334	0.247	3.183		0	0	0	
VOLUME FIU (GAL) IN-SITU	20,886	SOLIDS PER DAY (LB)	0	0	0	0	0	0	0			227,424	227,424	38,603	38,811		0	0	0	
WATER (LB)	94,886	MINUTES PER DAY OPERATION (MIN)	480	480	480	60	60	24	375			480	480	480	480		25	375	375	
TOTAL MASS (LB)	279,637	TOTAL VOLUME PER DAY (GALLONS)	153,600	144,000	144,000	3,000	18,000	7,520	7,500			170,487	170,487	156,192	12,192		7,500	112,500	37,500	
VOLUME WATER (GALLONS)	11,861	DAYS OF OPERATION	1.01	0.76	0.25	0	0	1.01	1.01			0.76	0.76	0.25	0.25		1.01	1.01	1.01	
TOTAL VOLUME (GALLONS)	22,461	TOTAL VOLUME (GALLONS)	155,136	109,440	36,000	0	0	7,595	7,575			129,570	129,570	39,048	3,048		7,575	113,625	37,875	
		TOTAL MASS SOLIDS (LB)	0	0	0	0	0	0	0			172,842	172,842	9,651	9,703		0	0	0	
		SOLIDS PER HOUR (LB/HR)	0	0	0	0	0	0	0			28,428	28,428	4,825	4,851		0	0	0	

FULL-SCALE MOCKUP MASS BALANCE TABLE – CONT.

FSMS INVENTORY		STREAM NUMBER	10	11	12	13	14	15	18	19
		STREAM DESCRIPTION	SREE SPRAYERS (FILTERED WATER)	EMMA, SPRAY WAND, AND DECON SPRAY RINGS (FILTERED WATER)	FILTRATE RECIRCULATION LOOP (FILTERED WATER)	HP JET PUMP SUPPLY (FILTERED WATER)		FROM UF TO FW TANK (FILTERED WATER)	MAKE-UP WATER	MAKE-UP WATER TO FILTRATE TANK
TOTAL SOLIDS (LB)	184,751							NOTE 3	NOTE 3	NOTE 3
BENTOGROUT (LB)	3,791	FLOW (GPM)	6	40	180	10		20	200	200
FIU SIMULANT (LB)	180,960	% SOLIDS (WT)	0	0	0	0		0	0	0
VOLUME BENTOGROUT (GAL) IN-SITU	1,575	SOLIDS PER GAL (LB)	0	0	0	0		0	0	0
VOLUME FIU (GAL) IN-SITU	20,886	SOLIDS PER DAY (LB)	0	0	0	0		0	0	0
WATER (LB)	94,886	MINUTES PER DAY OPERATION (MIN)	240	60	30	480		375	90	30
TOTAL MASS (LB)	279,637	TOTAL VOLUME PER DAY (GALLONS)	1,440	2,400	5,400	4,800		7,500	18,000	6,000
VOLUME WATER (GALLONS)	11,861	DAYS OF OPERATION	0.25	5	0.25	0.25		1.01	7.50	1.00
TOTAL VOLUME (GALLONS)	22,461	TOTAL VOLUME (GALLONS)	360	12,000	1,350	1,200		7,575	135,000	6,000
		TOTAL MASS SOLIDS (LB)	0	0	0	0		0	0	0
		SOLIDS PER HOUR (LB/HR)	0	0	0	0		0	0	0

CLOUDED AREAS REFLECT THE DELETION OF THE SAMPLING SYSTEM

NOTES:

1. MASS BALANCE TABLES TO BE USED IN CONJUNCTION WITH 10FMD007, 10FMD008, 10FMD009, 10FMD010 & 10FMD011.
2. STREAM OF APPROXIMATE WASTE RETRIEVED (SLURRY SOLIDS 15% – DECANT SOLIDS 2 %).
3. DURING ICAT & SOT OPERATION OF THE FULL-SCALE MOCKUP (FSM), COMPONENTS AND FLOW STREAMS OF THE PERMANENT FACILITY WILL BE USED. CERTAIN FLOW STREAM IDENTIFIERS HAVE BEEN DUPLICATED ON THIS MASS BALANCE WHEN COMPARED TO OTHER SYSTEM MASS BALANCES. THE STREAMS ARE DUPLICATED BECAUSE THE MASS BALANCE VALUES ARE DIFFERENT DURING FSM OPERATION AS OPPOSED TO NORMAL SYSTEM OPERATION. ALL OF THE DUPLICATE STREAM NUMBERS DO NOT APPEAR ON THE FULL-SCALE MOCKUP SYSTEM (FSMS) PROCESS FLOW DIAGRAMS. THE LIST BELOW SHOWS THE LOCATION OF THE DUPLICATE STREAMS NOT SHOWN ON THE FSMS PROCESS FLOW DIAGRAMS. THE VALUES PRESENTED ON THIS DRAWING SHOULD ONLY BE USED FOR FSM OPERATION. STREAM NUMBERS ARE PRESENTED IN THE ORDER THEY APPEAR ON THE MASS BALANCE.

STREAM NUMBER	DRAWING
37	12FMD001 12FMD002 12FMD003 12FMD004 12FMD005
4	12FMD001 12FMD008
30	12FMD001
8	12FMD001 12FMD007
28	12FMD007 12FMD008
29	12FMD007 12FMD008
9	12FMD007 12FMD008
15	12FMD007 12FMD008
18	12FMD001
19	12FMD008

000388

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REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLE

SIZE	SCALE	DWG. NO.	REV
D	NONE	10FMD006	2

FILENAME: 10FMD006.DWG

INFORMATION ONLY

3157

SILO 2 – AWRS MASS BALANCE TABLE

INVENTORY		STREAM NUMBER	37	1	1	2	3	4	30	5	6	7	7	7	21	22	8	28	29
		STREAM DESCRIPTION	DECANT FROM TTA TO UF MAKE-UP CONNECTION	DECANT FROM UF MAKE-UP CONNECTION (BULK RETRIEVAL)	DECANT FROM UF MAKE-UP CONNECTION (CATS)	DECANT DILUTION WATER	DECANT FLUSH WATER	DECANT WATER TO BE FILTERED	DECANT MAKE-UP TO FILTER PROCESS TANK			SLURRY DISCHARGE (BULK RETRIEVAL)	SLURRY DISCHARGE RETRIEVED WASTE (BULK RETRIEVAL)	SLURRY DISCHARGE (CATS WITH DILUTION WATER)	SLURRY DISCHARGE (FROM SREE TO SLURRY PUMP)		SLURRY LINE FROM UF SYSTEM	UF SUPPLY FROM PROCESS TANK	UF RETURN TO PROCESS TANK
													NOTE 2						
TOTAL SOLIDS (LB)	9,130,965	FLOW (GPM)	320	300	300	50	300	320	20			330.8	330.8	321	21		300	300	280
BENTOGROUT (LB)	187,369	% SOLIDS (WT)	2.0	2.0	2.0	2.0	2.0	2.0	2.0			15.0	13.38	4.18	31.0		4.0	2.0	2.14
K-65 (LB)	8,943,596	SOLIDS PER GAL (LB)	0.167	0.167	0.167	0.167	0.167	0.167	0.167			1.315	1.164	0.351	2.983		0.336	0.167	0.179
VOLUME BENTOGROUT (GALLONS) IN-SITU	83,011	SOLIDS PER DAY (LB)	25,654	24,050	24,050	501	3,006	1,256	1,253			208,762	184,751	54,118	30,071		2,519	18,789	18,770
VOLUME K-65 (GALLONS) IN-SITU	751,141	MINUTES PER DAY OPERATION (MIN)	480	480	480	60	60	24	375			480	480	480	480		25	375	375
WATER (LB)	3,911,803	TOTAL VOLUME PER DAY (GALLONS)	153,600	144,000	144,000	3,000	18,000	7,520	7,500			158,777	158,777	154,080	10,080		7,500	112,500	105,000
TOTAL MASS (LB)	13,042,768	DAYS OF OPERATION	62.13	46.95	15.18	0.00	0.00	64.63	64.63			46.95	46.95	15.18	15.18		64.63	64.63	64.63
VOLUME WATER (GALLONS)	468,749	TOTAL VOLUME (GALLONS)	9,543,792	6,761,069	2,186,236	0	0	486,048	484,755			7,454,874	7,454,874	2,339,272	153,037		484,755	7,271,332	6,786,577
TOTAL VOLUME (GALLONS)	834,152	TOTAL MASS SOLIDS (LB)	1,593,969	1,129,209	365,137	0	0	81,178	80,962			9,801,761	8,674,417	821,626	456,548		162,841	1,214,431	1,213,150
CURIES	9,682	SOLIDS PER HOUR (LB/HR)	3,207	3,006	3,006	501	3,006	3,207	200			26,095	23,094	6,765	3,759		6,047	3,006	3,003
		CURIES	1,690	1,197	387	0	0	86	86			10,393	9,198	871	484		173	1,288	1,286

SILO 2 – AWRS MASS BALANCE TABLE – CONT.

INVENTORY		STREAM NUMBER	9	10	11	12	13	14	15	16	17	18	19	20	23	24	25	26	27
		STREAM DESCRIPTION		SREE SPRAYERS (FILTERED WATER)	EMMA, SPRAY WAND, AND DECON SPRAY RINGS (FILTERED WATER)	FILTRATE RECIRCULATION LOOP (FILTERED WATER)	HP JET PUMP SUPPLY (FILTERED WATER)		FROM UF TO FW TANK (FILTERED WATER)	TTA HP DECON (FILTERED WATER)	AWWTP SUPPLY	MAKE-UP WATER TO TTA	MAKE-UP WATER TO FILTRATE TANK	RCS CONDENSATE RETURN	STORAGE TANK 2B SUMP DRAIN	STORAGE TANK 1B SUMP DRAIN	STORAGE TANK 2A SUMP DRAIN	STORAGE TANK 1A SUMP DRAIN	FROM TTA SUMP PUMP LINE
															NOTE 3	NOTE 3	NOTE 3	NOTE 3	NOTE 3
TOTAL SOLIDS (LB)	9,130,965	FLOW (GPM)		6	40	150	10		20	40	5	200	200	50	0	0	0	0	50
BENTOGROUT (LB)	187,369	% SOLIDS (WT)		0	0	0	0		0	0	0	0	0	0	20	20	20	20	20
K-65 (LB)	8,943,596	SOLIDS PER GAL (LB)		0	0	0	0		0	0	0	0	0	0	1.80	1.80	1.80	1.80	1.80
VOLUME BENTOGROUT (GALLONS) IN-SITU	83,011	SOLIDS PER DAY (LB)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
VOLUME K-65 (GALLONS) IN-SITU	751,141	MINUTES PER DAY OPERATION (MIN)		480	60	480	480		375	20	0	90	30	60	0	0	0	0	0
WATER (LB)	3,911,803	TOTAL VOLUME PER DAY (GALLONS)		2,880	2,400	72,000	4,800		7,500	800	0	18,000	6,000	3,000	0	0	0	0	0
TOTAL MASS (LB)	13,042,768	DAYS OF OPERATION		15.18	5.00	15.18	15.18		64.63	0.00	0.00	21.00	21.00	4.00	0	0	0	0	0
VOLUME WATER (GALLONS)	468,749	TOTAL VOLUME (GALLONS)		43,725	12,000	1,093,118	72,875		484,755	0	0	378,000	126,000	12,000	0	0	0	0	0
TOTAL VOLUME (GALLONS)	834,152	TOTAL MASS SOLIDS (LB)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
CURIES	9,682	SOLIDS PER HOUR (LB/HR)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
		CURIES		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0

CLOUDED AREAS REFLECT THE DELETION OF THE SAMPLING SYSTEM

NOTES:

1. MASS BALANCE TABLES TO BE USED IN CONJUNCTION WITH DRAWINGS 11FMD003 THRU 11FMD009, & 12FMD001 THRU 12FMD008.
2. STREAM OF APPROXIMATE WASTE RETRIEVED (SLURRY SOILDS 15% – DECANT SOLIDS 2%).
3. TTA TANK FOUNDATION DRAIN.

000389

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
MASS BALANCE TABLE – SHT 1

SIZE	SCALE:	DWG. NO.	REV
D	NONE	11FMD001	2

FILENAME: 11FMD001.DWG

INFORMATION ONLY

3157

SILO 1 – AWRS MASS BALANCE TABLE

INVENTORY		STREAM NUMBER	37	1	1	2	3	4	30	5	6	7	7	7	21	22	8	28	29
		STREAM DESCRIPTION	DECANT FROM TTA TO UF MAKE-UP CONNECTION	DECANT FROM UF MAKE-UP CONNECTION (BULK RETRIEVAL)	DECANT FROM UF MAKE-UP CONNECTION (CATS)	DECANT DILUTION WATER	DECANT FLUSH WATER	DECANT WATER TO BE FILTERED	DECANT MAKE-UP TO FILTER PROCESS TANK			SLURRY DISCHARGE (BULK RETRIEVAL)	SLURRY DISCHARGE RETRIEVED WASTE (BULK RETRIEVAL)	SLURRY DISCHARGE (CATS WITH DILUTION WATER)	SLURRY DISCHARGE (FROM SREE TO SLURRY PUMP)		SLURRY LINE FROM UF SYSTEM	UF SUPPLY FROM PROCESS TANK	UF RETURN TO PROCESS TANK
													NOTE 2						
TOTAL SOLIDS (LB)	10,539,229	FLOW (GPM)	320	300	300	50	300	320	20			330.8	330.8	321	21		300	300	280
BENTOGROUT (LB)	214,613	% SOLIDS (WT)	2.0	2.0	2.0	2.0	2.0	2.0	2.0			15.0	13.38	4.18	31.0		4.0	2.0	2.14
K-65 (LB)	10,324,616	SOLIDS PER GAL (LB)	0.167	0.167	0.167	0.167	0.167	0.167	0.167			1.315	1.164	0.351	2.983		0.336	0.167	0.179
VOLUME BENTOGROUT (GALLONS) IN-SITU	95,130	SOLIDS PER DAY (LB)	25,654	24,050	24,050	501	3,006	1,256	1,253			208,762	184,751	54,118	30,071		2,519	18,789	18,770
VOLUME K-65 (GALLONS) IN-SITU	867,074	MINUTES PER DAY OPERATION (MIN)	480	480	480	60	60	24	375			480	480	480	480		25	375	375
WATER (LB)	4,510,370	TOTAL VOLUME PER DAY (GALLONS)	153,600	144,000	144,000	3,000	18,000	7,520	7,500			158,777	158,777	154,080	10,080		7,500	112,500	105,000
TOTAL MASS (LB)	15,049,599	DAYS OF OPERATION	69.78	54.57	15.21	0.00	0.00	72.28	72.28			54.57	54.57	15.21	15.21		72.28	72.28	72.28
VOLUME WATER (GALLONS)	540,475	TOTAL VOLUME (GALLONS)	10,718,260	7,858,042	2,190,327	0	0	543,548	542,103			8,664,415	8,664,415	2,343,650	153,323		542,103	8,131,538	7,589,435
TOTAL VOLUME (GALLONS)	962,204	TOTAL MASS SOLIDS (LB)	1,790,124	1,312,421	365,820	0	0	90,781	90,540			11,392,080	10,081,826	823,163	457,403		182,106	1,358,099	1,356,667
CURIES	17,363	SOLIDS PER HOUR (LB/HR)	3,207	3,006	3,006	501	3,006	3,207	200			26,095	23,094	6,765	3,759		6,047	3,006	3,003
		CURIES	2,949	2,162	603	0	0	150	149			18,768	16,609	1,356	754		300	2,237	2,235

SILO 1 – AWRS MASS BALANCE TABLE – CONT.

INVENTORY		STREAM NUMBER	9	10	11	12	13	14	15	16	17	18	19	20	23	24	25	26	27
		STREAM DESCRIPTION		SREE SPRAYERS (FILTERED WATER)	EMMA, SPRAY WAND, AND DECON SPRAY RINGS (FILTERED WATER)	FILTRATE RECIRCULATION LOOP (FILTERED WATER)	HP JET PUMP SUPPLY (FILTERED WATER)		FROM UF TO FW TANK (FILTERED WATER)	TTA HP DECON (FILTERED WATER)	AWWTP SUPPLY	MAKE-UP WATER TO TTA	MAKE-UP WATER TO FILTRATE TANK	RCS CONDENSATE RETURN	STORAGE TANK 2B SUMP DRAIN	STORAGE TANK 1B SUMP DRAIN	STORAGE TANK 2A SUMP DRAIN	STORAGE TANK 1A SUMP DRAIN	FROM TTA SUMP PUMP LINE
															NOTE 3	NOTE 3	NOTE 3	NOTE 3	NOTE 3
TOTAL SOLIDS (LB)	10,539,229	FLOW (GPM)		6	40	150	10		20	40	5	200	200	50	0	0	0	0	50
BENTOGROUT (LB)	214,613	% SOLIDS (WT)		0	0	0	0		0	0	0	0	0	0	20	20	20	20	20
K-65 (LB)	10,324,616	SOLIDS PER GAL (LB)		0	0	0	0		0	0	0	0	0	0	1.80	1.80	1.80	1.80	1.80
VOLUME BENTOGROUT (GALLONS) IN-SITU	95,130	SOLIDS PER DAY (LB)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
VOLUME K-65 (GALLONS) IN-SITU	867,074	MINUTES PER DAY OPERATION (MIN)		480	60	480	480		375	20	480	90	30	60	0	0	0	0	0
WATER (LB)	4,510,370	TOTAL VOLUME PER DAY (GALLONS)		2,880	2,400	72,000	4,800		7,500	800	2,400	18,000	6,000	3,000	0	0	0	0	0
TOTAL MASS (LB)	15,049,599	DAYS OF OPERATION		15.21	5.00	15.21	15.21		72.28	0.00	0.00	22.10	20.70	5.00	0	0	0	0	0
VOLUME WATER (GALLONS)	540,475	TOTAL VOLUME (GALLONS)		43,807	12,000	1,095,163	73,011		542,103	0	0	397,800	124,200	15,000	0	0	0	0	0
TOTAL VOLUME (GALLONS)	962,204	TOTAL MASS SOLIDS (LB)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
CURIES	17,363	SOLIDS PER HOUR (LB/HR)		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
		CURIES		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0

NOTES:

1. MASS BALANCE TABLES TO BE USED IN CONJUNCTION WITH DRAWINGS 11FMD003 THRU 11FMD009, 12FMD001 THRU 12FMD008, & 51FMD001.
2. STREAM OF APPROXIMATE WASTE RETRIEVED (SLURRY SOILDS 15% – DECANT SOLIDS 2%).
3. TTA TANK FOUNDATION DRAIN.

000390

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 824

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
MASS BALANCE TABLE – SHT 2

SIZE D | SCALE: NONE | DWG. NO. 11FMD002 | REV 2

FILENAME: 11FMD002.DWG

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NOTES:

1. MASS BALANCE TABLE TO BE USED IN CONJUNCTION WITH DRAWINGS 13FMD002, 13FMD003, & 13FMD004.
2. STREAM OF APPROXIMATE WASTE RETRIEVED (SLURRY SOILDS 15% – DECANT SOILDS 2%).
3. TTA TANK FOUNDATION DRAIN.

TYPICAL TTA TANK – MASS BALANCE

SILO 1 TTA TANK INVENTORY		STREAM NUMBER	1	2	3	7	7	16	23	24	25	26	27
		STREAM DESCRIPTION	SLUICING WATER	DILUTION WATER	FLUSH WATER	SLURRY DISCHARGE	RETRIEVED WASTE	TTA HP DECON (FILTERED WATER)	STORAGE TANK 2B SUMP DRAIN	STORAGE TANK 2A SUMP DRAIN	STORAGE TANK 1B SUMP DRAIN	STORAGE TANK 1A SUMP DRAIN	FROM TTA SUMP PUMP TO SLURRY LINE
TOTAL SOLIDS (LB)	5,270,000						NOTE 2		NOTE 3	NOTE 3	NOTE 3	NOTE 3	NOTE 3
BENTOGROUT (LB)	107,000	FLOW (GPM)	300	50	300	331	331	40	0	0	0	0	300
K-65 (LB)	5,160,000	% SOLIDS (WT)	2.0	2.0	2.0	15.0	13.38	0	20.0	20.0	20.0	20.0	20.0
WATER (LB)	4,660,000	SOLIDS PER GAL (LB)	0.167	0.167	0.167	1.315	1.164	0	1.798	1.798	1.798	1.798	1.798
TOTAL MASS (LB)	9,930,000	SOLIDS PER DAY (LB)	24,050	501	3,006	208,897	184,944	0	0	0	0	0	0
VOLUME WATER (GALLONS)	559,000	MINUTES PER DAY OPERATION (MIN)	480	60	60	480	480	20	0	0	0	0	0
TOTAL VOLUME (GALLONS)	750,000	TOTAL VOLUME PER DAY (GALLONS)	144,000	3,000	18,000	158,880	158,880	800	0	0	0	0	0
TOTAL SOLIDS (GALLONS)	190,000	DAYS OF OPERATION	28.49	0	0	28.49	28.49	5	0	0	0	0	0
CURIES	8,680	TOTAL VOLUME (GALLONS)	4,102,986	0	0	4,526,961	4,526,961	4,000	0	0	0	0	0
		TOTAL MASS SOLIDS (LB)	685,266	0	0	5,952,105	5,269,615	0	0	0	0	0	0
		SOLIDS PER HOUR (LB/HR)	3,006	501	3,006	26,112	23,118	0	0	0	0	0	0
		CURIES	1,129	0	0	9,806	8,681	0	0	0	0	0	0

TYPICAL TTA TANK – MASS BALANCE

SILO 2 TTA TANK INVENTORY		STREAM NUMBER	1	2	3	7	7	16	23	24	25	26	27
		STREAM DESCRIPTION	SLUICING WATER	DILUTION WATER	FLUSH WATER	SLURRY DISCHARGE	RETRIEVED WASTE	TTA HP DECON (FILTERED WATER)	STORAGE TANK 2B SUMP DRAIN	STORAGE TANK 2A SUMP DRAIN	STORAGE TANK 1B SUMP DRAIN	STORAGE TANK 1A SUMP DRAIN	FROM TTA SUMP PUMP TO SLURRY LINE
TOTAL SOLIDS (LB)	4,570,000						NOTE 2		NOTE 3	NOTE 3	NOTE 3	NOTE 3	NOTE 3
BENTOGROUT (LB)	93,700	FLOW (GPM)	300	50	300	331	331	40	0	0	0	0	300
K-65 (LB)	4,470,000	% SOLIDS (WT)	2.0	2.0	2.0	15.0	13.38	0	20.0	20.0	20.0	20.0	20.0
WATER (LB)	4,250,000	SOLIDS PER GAL (LB)	0.167	0.167	0.167	1.315	1.164	0	1.798	1.798	1.798	1.798	1.798
TOTAL MASS (LB)	8,820,000	SOLIDS PER DAY (LB)	24,050	501	3,006	208,897	184,944	0	0	0	0	0	0
VOLUME WATER (GALLONS)	510,000	MINUTES PER DAY OPERATION (MIN)	480	60	60	480	480	20	0	0	0	0	0
TOTAL VOLUME (GALLONS)	675,000	TOTAL VOLUME PER DAY (GALLONS)	144,000	3,000	18,000	158,880	158,880	800	0	0	0	0	0
TOTAL SOLIDS (GALLONS)	165,000	DAYS OF OPERATION	24.69	0	0	28.69	24.69	5	0	0	0	0	0
CURIES	4,840	TOTAL VOLUME (GALLONS)	3,554,740	0	0	3,922,063	3,922,063	4,000	0	0	0	0	0
		TOTAL MASS SOLIDS (LB)	593,700	0	0	5,156,778	4,565,483	0	0	0	0	0	0
		SOLIDS PER HOUR (LB/HR)	3,006	501	3,006	26,112	23,118	0	0	0	0	0	0
		CURIES	630	0	0	5,469	4,842	0	0	0	0	0	0

INFORMATION ONLY

UNCONTROLLED

000391

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2					REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/07/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

PE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE

TRANSFER TANK WASTE RETRIEVAL
PROCESS FLOW DIAGRAM
MASS BALANCE TABLE

SIZE	SCALE:	DWG. NO.	REV
D	NONE	13FMD001	2

FILENAME: 13FMD001.DWG

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3157

DECANT SUMP RETRIEVAL – AWRS MASS BALANCE TABLE

INVENTORY		STREAM NUMBER	31	34	40	41
		STREAM DESCRIPTION	SLUICE WATER FROM HP PUMP SKID	SLURRY FROM DECANT TANK TO VAC TRUCK	RINSE WATER TO VAC TRUCK	SLURRY FROM VAC TRUCK TO TTA TANK
TOTAL SLUDGE VOLUME (GAL)	1000	FLOW (GPM)	20.0	80.0	30.0	300.0
VOLUME K-65 (GAL) IN-SITU	477	% SOLIDS (WT)	0.0%	15.0%	0.0%	13.4%
VOLUME WATER (GAL) IN-SITU	523	SOLIDS PER GAL (LB/GAL)	0.000	1.310	0.000	1.170
K-65 (LB) IN-SITU	5686	SOLIDS PER HOUR (LB/HR)	0	6289	0	21058
WATER (LB) IN-SITU	4362	SOLIDS PER BATCH (LB/BATCH)	0	3275	0	3276
TOTAL MASS (LB) IN-SITU	10048	MINUTES PER BATCH OPERATION (MIN)	125	31	10	9
VOLUME OF SUPERNATE WATER IN-SITU (GAL)	2000	TOTAL VOLUME PER BATCH (GAL/BATCH)	2500	2500	300	2800
TOTAL VOLUME IN-SITU (GAL)	3000	NUMBER OF BATCHES	1.3	1.7	1.7	1.7
TOTAL TTA DISCHARGE (GAL)	4861	TOTAL VOLUME (GALLONS)	3340	4340	521	4861
		TOTAL MASS SOLIDS (LB)	0	5686	0	5686
CURIES	10	CURIES	0	10	0	10

NOTES:

1. MASS BALANCE TABLE TO BE USED IN CONJUNCTION WITH DRAWINGS 14FMD002, 14FMD003, & 14FMD004.

INFORMATION ONLY

UNCONTROLLED

000392

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	SWH		PRELIMINARY DESIGN SUBMITTAL

RPE

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
DECANT SUMP RETRIEVAL SYSTEM
PROCESS FLOW DIAGRAM
MASS BALANCE TABLE

SIZE	SCALE:	DWG. NO.	REV
D	NONE	14FMD001	2

FILENAME: 14FMD001.DWG

G:\DRAFT\FWDFSILO3\14FMD001.dwg Thu Jun 22 14:03:36 2006

3157

PHASE 1 – SILO 1 AND SILO 2 HEADSPACE REDUCTION

STREAM NUMBER	1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15	16	17	18	19	20
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	1081	1081	--	2161	2161	2161	2919	976	976	--	--	--	--	210	40219	40436	758	--	--	--	--	--
WATER (LBS/HR)	20	20	--	41	2	2	2	1	1	--	--	39	--	0	757	757	0	--	12519	--	--	--
TOTAL, (LBS/HR)	1101	1101	--	2202	2163	2163	2921	977	977	--	--	39	--	210	40976	41193	758	--	12519	--	--	--
FLOW (CFM)	250	250	--	500	454	454.00	649	225	225	--	--	--	--	50	9310	9360	175	--	--	--	--	--
FLOW (GPM)	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	25	--	--	--
RADON (PICOCURIES/L)	252197	249622	--	250910	276253	27	27	27	27	--	--	138043	--	27	0	0.144	27	--	2443	--	--	--
RADON (CURIES/HR)	1.07E-01	1.06E-01	--	2.13E-01	2.13E-01	2.08E-05	2.97E-05	1.03E-05	1.03E-05	--	--	2.44E-06	--	2.29E-06	0.00E+00	2.29E-06	8.0E-06	--	1.39E-05	--	--	--
TEMPERATURE (DEG F)	75	75	--	75	36	40	51	73	73	--	--	40	--	73	75	75	73	--	--	--	--	--
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NOTES	RELATIVE HUMIDITY= 100% RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY= 100% RADON CONCENTRATION STEADY STATE	TTA NOT FUNCTIONAL IN PHASE 1	FLOW REPRESENTS SILOS 1 AND 2	CHILLER CONDITIONS AIR TO 40°F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT			TTA NOT FUNCTIONAL IN PHASE 1	TTA NOT FUNCTIONAL IN PHASE 1		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 1	RELATIVE HUMIDITY= 14.2%	NOTE 2	RELATIVE HUMIDITY= 99.5%	FLOW ENTERS FAN SUCTION AFTER CARBON BEDS		INTERMITTENT FLOW; DECAYED BY STORAGE	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 1

PHASE 2A – SILO 1 RETRIEVAL, SILO 2 HEADSPACE REDUCTION, TTA VENTILATION

STREAM NUMBER	1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15	16	17	18	19	20
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	1081	1081	1081	3243	3243	3243	4326	--	976	1081	--	--	--	2267	40233	42511	1084	--	--	324	324	324
WATER (LBS/HR)	20	20	20	61	3	3	3	--	1	20	--	58	--	2	758	760	0	--	12519	6	6	6
TOTAL, (LBS/HR)	1101	1101	1101	3304	3246	3246	4329	--	977	1101	--	58	--	2269	40991	43271	1084	--	12519	330	330	330
FLOW (CFM)	250	250	250	750	681	681	960	--	225	250	--	--	--	525	9310	9835	250	--	--	75	75	75
FLOW (GPM)	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	25	--	--	--
RADON (PICOCURIES/L)	1665166	251623	272500	729763	803472	1701	1701	--	1701	0	--	401500	--	1701	0	90	1701	--	7106	0	0	0
RADON (CURIES/HR)	2.07E-01	1.07E-01	1.16E-01	9.30E-01	9.30E-01	1.97E-03	2.77E-03	--	6.56E-04	0.00E+00	--	1.07E-05	--	1.52E-03	0.00E+00	1.52E-03	7.07E-04	--	4.03E-05	0.00E+00	0.00E+00	0.00E+00
TEMPERATURE (DEG F)	75	75	75	75	36	40	51	--	73	75	--	40	--	73	75	75	73	--	--	75	75	75
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NOTES	RELATIVE HUMIDITY=100 % RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100 % RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100 % RADON CONCENTRATION STEADY STATE	FLOW REPRESENTS SILOS 1 AND 2 PLUS TTA	CHILLER CONDITIONS AIR TO 40°F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT	NO RECYCLE FLOW TO SILO1 IN PHASE 2A		NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUAL TO STREAM 8 DURING RECIRC OF TTA		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 2	RELATIVE HUMIDITY=4.4%	NOTE 2	RELATIVE HUMIDITY= 95.1%			INTERMITTENT FLOW; DECAYED BY STORAGE	SILO 1	SILO 1	SILO 1

PHASE 2B – SILO 1 RETRIEVAL, TTA VENTILATION

STREAM NUMBER	1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15	16	17	18	19	20
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	--	1081	2161	3242	3242	3242	4326	--	--	2161	--	--	--	3242	40233	43487	1084	--	--	324	324	324
WATER (LBS/HR)	--	20	41	61	2	2	3	--	--	41	--	58	--	2	758	760	1	--	12519	6	6	6
TOTAL, (LBS/HR)	--	1101	2202	3303	3244	3244	4329	--	--	2202	--	58	--	3246	40991	44247	1085	--	12519	330	330	330
FLOW (CFM)	--	250	500	750	681	681	960	--	--	500	--	--	--	750	9310	10060	250	--	--	75	75	75
FLOW (GPM)	--	--	--	--	--	--	--	--	--	--	--	0.12	--	--	--	--	--	--	25	--	--	--
RADON (PICOCURIES/L)	--	912497	211373	445081	490036	1037	1037	--	--	0	--	244872	--	1037	0	72	1037	--	4334	0	0	0
RADON (CURIES/HR)	--	3.88E-01	1.80E-01	5.67E-01	5.67E-01	1.20E-03	1.69E-03	--	--	0.00E+00	--	6.50E-06	--	1.32E-03	0.00E+00	1.32E-03	4.41E-04	--	2.46E-05	0.00E+00	0.00E+00	0.00E+00
TEMPERATURE (DEG F)	--	75	75	75	36	40	51	--	--	75	--	40	--	73	75	75	73	--	--	75	75	75
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NOTES	NO FLOW FROM SILO 1 IN PHASE 2B	RELATIVE HUMIDITY=100% RADON CONCENTRATION STEADY STATE	RELATIVE HUMIDITY=100% RADON CONCENTRATION STEADY STATE	FLOW REPRESENTS SILOS 1 AND 2 PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST + FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT	NO RECYCLE FLOW TO SILOS IN PHASE 2B	NO RECYCLE FLOW TO SILOS IN PHASE 2B	NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA		FUTURE WASTE TREATMENT AREA NOT FUNCTIONAL IN PHASE 2B	RELATIVE HUMIDITY=4.4%	NOTE 2	RELATIVE HUMIDITY= 92.8%			INTERMITTENT FLOW; DECAYED BY STORAGE	SILO 2	SILO 2	SILO 2

000393

NOTES:

1. FOR FLOW DIAGRAMS SEE DRAWINGS 20FMD003 THRU 20FMD011.
2. STREAM 13 FLOW FROM 77FMD002.
3. INFILTRATION INTO SILOS ASSUMED TO BE 10% OF EXHAUST FLOWRATE.
4. AIR STREAMS FROM CARBON BED DRYING FAN (FAN-20-003) TO DESICCANT DRYERS OR HEPA FILTERS ARE NOT INCLUDED IN THE MASS BALANCE. THESE FLOW STREAMS ARE NOT PART OF NORMAL OPERATIONS, BUT ARE USED FOR MAINTENANCE ACTIVITES TO RECLAIM CARBON BED PERFORMANCE.

INFORMATION ONLY

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	BJD	GCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-001
1	03/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	11/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT, P.E. NO. E-64418, 5/15/00, REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE: RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLES – SHT 1

SIZE: D | SCALE: NONE | DWG. NO. 20FMD001 | REV 2

FILENAME: 20FMD001.DWG

3157

PHASE 2C – TTA VENTILATION

STREAM NUMBER	1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15	16	17	18	19	20	21
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	AIR FLOW FROM DECANT SUMP
AIR (LBS/HR)	--	--	2161	2161	2161	2161	2919	--	--	2161	--	--	--	2161	40233	42401	758	0.00	--	--	--	--	360.12
WATER (LBS/HR)	--	--	41	41	2	2	2	--	--	41	--	39	--	1	758	759	1	0.00	12519	--	--	--	6.78
TOTAL, (LBS/HR)	--	--	2202	2202	2163	2163	2921	--	--	2202	--	39	--	2162	40991	43160	759	0.00	12519	--	--	--	366.90
FLOW (CFM)	--	--	500	500	454	454	649	--	--	500	--	--	--	500	9310	9810	175	0.00	--	--	--	--	83.00
FLOW (GPM)	--	--	--	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--	25	--	--	--	--
RADON (PICOCURIES/L)	--	--	211373	211373	232723	23	23	--	--	0	--	116292	--	23	0	1	23	0	2058	--	--	--	--
RADON (CURIES/HR)	--	--	1.80E-01	1.80E-01	1.80E-01	1.75E-05	2.50E-05	--	--	0.00E+00	--	2.06E-06	--	1.93E-05	0.00E+00	1.93E-05	6.7E-06	0.00E+00	1.17E-05	--	--	--	--
TEMPERATURE (DEG F)	--	--	75	75	36	40	51	--	--	75	--	40	--	73	75	75	73	75	--	--	--	--	75
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NOTES	NO FLOW FROM SILO IN PHASE 2C	NO FLOW FROM SILO IN PHASE 2C		FLOW REPRESENTS WTA PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT	NO FLOW TO SILOS IN PHASE 2C	NO FLOW TO SILOS IN PHASE 2C	NO FLOW IN STREAM 9 DURING RECIRC OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA		FUTURE WASTE TREATMENT NOT FUNCTIONAL IN PHASE 2C	RELATIVE HUMIDITY=4.4%	NOTE 2	RELATIVE HUMIDITY= 95.1%			INTERMITTENT FLOW; DECAYED BY STORAGE	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 2C	DECANT SUMP NOTE 3

HOLD

PHASE 3 – TTA VENTILATION, FUTURE WASTE TREATMENT

STREAM NUMBER	1	2	3	4	5	6	6A	7	8	9	9A	10	11	12	13	14	15	16	17	18	19	20
COMPONENT	AIR FLOW FROM SILO 1	AIR FLOW FROM SILO 2	AIR FLOW FROM TTA	AIR TO CHILLER	AIR TO CARBON BED	AIR FROM CARBON BED	FAN INLET (TREATED GAS + FAN RECYCLE + MAKEUP)	AIR TO SILO 1	AIR TO SILO 2	MAKEUP AIR TO TTA	RECYCLE AIR TO TTA	CONDENSATE TO HOLD-UP TANKS	AIR FROM FUTURE WASTE TREATMENT AREA	RCS TO STACK	BUILDING VENT TO STACK	AIR TO STACK	FAN RECYCLE FLOW	MAKE-UP AIR	CONDENSATE TO FILTRATE TANKS	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW	EQUIPMENT ENCLOSURE AIR INFLOW
AIR (LBS/HR)	--	--	2161	4321.4	4321	4321	4321	--	--	2161	--	--	2161	4321	48233	44551	--	--	--	--	--	--
WATER (LBS/HR)	--	--	41	82	3	3	3	--	--	41	--	78	41	3	758	761	--	--	12519	--	--	--
TOTAL, (LBS/HR)	--	--	2202	4403	4324	4324	4324	--	--	2202	--	78	2202	4324	40991	45312	--	--	12519	--	--	--
FLOW (CFM)	--	--	500	1000.00	908	908	908	--	--	500	--	--	500	979	9310	10289	--	--	--	--	--	--
FLOW (GPM)	--	--	--	--	--	--	--	--	--	--	--	0.16	--	--	--	--	--	--	25	--	--	--
RADON (PICOCURIES/L)	--	--	710019	565009	622078	6140	6140	--	--	0	--	310854	420000	6140	0	584	--	--	5501	--	--	--
RADON (CURIES/HR)	--	--	6.03E-01	9.60E-01	9.60E-01	9.47E-03	9.47E-03	--	--	0.00E+00	--	1.10E-05	3.57E-01	1.02E-02	0.00E+00	1.02E-02	--	--	3.12E-05	--	--	--
TEMPERATURE (DEG F)	--	--	75	75	36	40	40	--	--	75	--	40	75	62	75	75	--	--	--	--	--	--
PRESSURE (INCHES WC)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NOTES	NO FLOW FROM SILO IN PHASE 3	NO FLOW FROM SILO IN PHASE 3		FLOW REPRESENTS WTA PLUS TTA	CHILLER CONDITIONS AIR TO 40F AND 15% RELATIVE HUMIDITY	RADON REMOVAL BASED ON K=13 AND 4 CARBON BEDS	FLOW IS CARBON BED EXHAUST PLUS FAN RECYCLE FLOW + MAKEUP AIR. INCL. FAN HEAT	NO FLOW TO OR FROM SILOS IN PHASE 3	NO FLOW TO OR FROM SILOS IN PHASE 3	NO FLOW IN STREAM 9 DURING RECIRUCLATION OF TTA	9A FLOW EQUALS 2X STREAM 8 IN PHASE 2A DURING RECIRC OF TTA			RELATIVE HUMIDITY=6.4%	NOTE 2	RELATIVE HUMIDITY= 93.9%	NO FAN RECYCLE IN PHASE 3			EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3	EQUIPMENT ENCLOSURES NOT INSTALLED IN PHASE 3

HOLD

INFORMATION ONLY

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NOTES:

1. FOR FLOW DIAGRAMS SEE DRAWINGS 20FMD003 THRU 20FMD011.
2. STREAM 13 ORIGINATES ON 77FMD002.
3. STREAM 21 IN PHASE 2C – FOR INFORMATION ONLY – NOT INCLUDED IN OVERALL MASS BALANCE DUE TO DURATION OF DECANT SUMP ACTIVITIES BEING LESS THAN ONE WEEK WITH LIMITED KNOWLEDGE OF RADON CONCENTRATIONS IN TANK.
4. AIR STREAMS FROM CARBON BED DRYING FAN (FAN-20-003) TO DESICCANT DRYERS OR HEPA FILTERS ARE NOT INCLUDED IN THE MASS BALANCE. THESE FLOW STREAMS ARE NOT PART OF NORMAL OPERATIONS, BUT ARE USED FOR MAINTENANCE ACTIVITIES TO RECLAIM CARBON BED PERFORMANCE.

HOLD

THE ORIGINAL DRAWING AND SUBSEQUENT REVISIONS THEREOF, WITH APPROVAL NAMES, INITIALS, AND THE PE SEAL, IF APPLICABLE, ARE MAINTAINED IN THE FILES OF FWENC.

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
2	05/15/00	BJD	CCH	KDR	REVISED PER CHANGE PROPOSAL CP-00-001
1	01/07/00	BJD	SWH	KDR	CERTIFIED FOR CONSTRUCTION
0	01/01/99	BJD	KR		PRELIMINARY DESIGN SUBMITTAL

PE: KENNETH D. RICKETT, P.E. NO. E-64418, 5/15/00, REVISION 2

		DATE
DRAWN BY	B J DAVIS	01/07/00
DESIGNED BY	B J DAVIS	01/07/00
CHECKED BY	S W HUNGATE	01/07/00
APPROVED BY	KENNETH RICKETT	01/07/00
APPROVED BY	JOHN LAWSON	01/07/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE: RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLES – SHT 2

SIZE: D | SCALE: NONE | DWG. NO. 20FMD002 | REV 2

FILENAME: 20FMD002.DWG

INFORMATION ONLY

RCS BUILDING VENTILATION

STREAM NUMBER	1	2	3	4	5	13
COMPONENT	TOTAL HVAC SUPPLY	RCS BUILDING 1ST FLOOR SUPPLY	RCS BUILDING 2ND FLOOR SUPPLY	RCS BUILDING 2ND FLOOR EXHAUST	RCS BUILDING 1ST FLOOR COMBINED EXHAUST	BUILDING VENTILATION EXHAUST TO STACK
AIR (LBS/HR)	37,602	28,765	8,837	9,834	30,497	40,331
WATER (LBS/HR)	688	529	162	181	561	741
TOTAL (LBS/HR)	38,290	29,294	8,999	10,015	31,058	41,072
FLOW (CFM)	8,680	6,640	2,040	2,270	7,040	9,310
FLOW (GPM)	--	--	--	--	--	--
RADON (PICOCURIES/L)	0	0	0	0	0	0
RADON (CURIES/HR)	0	0	0	0	0	0
TEMPERATURE (DEG F)	75	75	75	75	75	75
PRESSURE (INCHES WC)	--	--	--	--	--	--
NOTES	RELATIVE HUMIDITY = 100%					NOTE 2

NOTES:

3157

1. FOR FLOW DIAGRAMS SEE DRAWINGS 77FMD003, & 77FMD005.
2. STREAM 13 ALSO APPEARS ON 20FMD002.
3. RCS BUILDING WILL BE VENTILATED TO MAINTAIN A SLIGHTLY NEGATIVE PRESSURE WITHIN EACH BUILDING. DISCHARGE WILL BE APPROXIMATELY 10% GREATER THAN SUPPLY TO MAINTAIN NEGATIVE PRESSURE BOUNDARY.

000395

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
C	05/15/00	BJD			REVISED PER CP-00-001 & ISSUED FOR 90% REVIEW
B	01/07/00	BJD			ISSUED FOR OHIO EPA REVIEW
A		BJD			PRELIMINARY DESIGN SUBMITTAL

RPE

DRAWN BY BJD DATE 5-15-00
DESIGNED BY BJD DATE 5-15-00
CHECKED BY DATE
APPROVED BY DATE
APPROVED BY DATE

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
MISC FACILITIES HVAC SYSTEM
HVAC FLOW DIAGRAM
MASS BALANCE TABLE

SIZE D | SCALE: NONE | DWG. NO. 77FMD002 | REV C

FILENAME: 77FMD002.DWG

INFORMATION ONLY

3157

Heat and Material Balances for All Materials

DOCUMENT NO. 624-P622-06

DRAWING NUMBER	DRAWING TITLE	REVISION
10FMD001	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE – RADON CONTROL	2
10FMD006	FULL-SCALE MOCKUP SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLE	2
11FMD001	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLE - SHT 1	2
11FMD002	SILO WASTE RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLE - SHT 2	2
13FMD001	TRANSFER TANK WASTE RETRIEVAL PROCESS FLOW DIAGRAM MASS BALANCE TABLE	2
14FMD001	DECANT SUMP RETRIEVAL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLE	2
20FMD001	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLES – SHT 1	2
20FMD002	RADON CONTROL SYSTEM PROCESS FLOW DIAGRAM MASS BALANCE TABLES – SHT 2	2
77FMD002	MISC FACILITIES HVAC SYSTEM HVAC FLOW DIAGRAM MASS BALANCE TABLE	C

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FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SYSTEM DESIGN DESCRIPTIONS

DOCUMENT NO.
624-P622-30, Rev. C

FOR THE

SILOS 1 AND 2
ACCELERATED WASTE RETRIEVAL PROJECT

SUBMITTED TO:

Fluor Fernald, Inc.

CONTRACT NO. FSC 624

June 5, 2000

3157

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000398

3157

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SYSTEM DESIGN DESCRIPTIONS

Revision C

Recommended by:

Foster Wheeler Engineering Manager **Date**

Approved by:

Foster Wheeler Project Manager **Date** 000399

3157

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3157

CONTENTS

1.0 INTRODUCTION 1
1.1 Document Purpose and Organization 1
1.2 Systems Identification 1
2.0 GENERAL OVERVIEW 3
2.1 Scope 3
2.2 Mining Strategy 3
2.2.1 Introduction and Purpose 3
2.2.2 Baseline Modifications 4
2.2.3 Retrieval Equipment Descriptions 5
2.2.4 Retrieval Mining Strategy 6
3.0 REQUIREMENTS AND BASES 10
4.0 SYSTEM DESIGN DESCRIPTION 11
4.1 Silo Waste Retrieval System 11
4.1.1 EMMA™ System 12
4.1.2 Bulk Retrieval System. 16
4.1.3 Conditioning And Transfer System 19
4.1.4 Silo Debris Retrieval System. 21
4.2 Radon Control System 21
4.2.1 Phase 1 - Radon Control in the Silo Headspaces 28
4.2.2 Phase 2A, 2B - Radon Control during Material Transfer 30
4.2.3 Phase 2C - Radon Control during Interim Storage 32
4.2.4 Phase 3 - Radon Control during Future Material Treatment 32
4.3 Decant Sump Waste Retrieval System 31
4.3.1 Deployment Strategy 31
4.3.2 Component Descriptions 31
4.4 TTA System 32
4.4.1 Full-Scale Mock-Up System. 35
4.4.2 Silo Waste Retrieval System. 34
4.4.3 Decant Sump Waste Retrieval System 35
4.4.4 Transfer from Tank Waste Retrieval System. 37
4.4.5 Transfer Storage Tanks 37
4.4.6 Transfer Storage Tanks Enclosure 38
4.4.7 Equipment Deck 39
4.4.8 Equipment Deck Enclosure 39
4.4.9 Transfer Piping 40
4.4.10 Diverter Valves 40
4.4.11 Diverter Valve Enclosures 38
4.4.12 Ultra-Filtration Equipment 40
4.4.13 Filtrate Storage Tank 41
4.4.14 Filter Process Tank 41
4.4.15 Filtrate Transfer 39
4.4.16 Decant Pumps 41
4.4.17 Decant Pump Enclosure 42
4.4.18 Sluicers 40
4.4.19 Sluicer Enclosures 42
4.4.20 Slurry Pumps 43
4.4.21 Slurry Pump Enclosures 43
4.4.22 Makeup Water Storage Tank 43

INFORMATION ONLY CONTENTS

3157

4.4.23 Makeup Water Transfer Pump 43
4.5 TTA Waste Retrieval System 43
4.5.1 Transfer Storage Tanks 42
4.5.2 Transfer Piping 42
4.5.3 Diverter Valves 42
4.5.4 Sluicers 45
4.5.5 Sluicer Enclosure 45
4.5.6 Slurry Pumps 45
4.5.7 Slurry Pump Enclosure 45
4.6 Facilities Decontamination System 45
4.6.1 Silos Decontamination and Fixative Application 43
4.6.2 Access/Decontamination/Packaging for Significant Structures and Components 43
4.6.3 Decontamination/Demolition at Completion of FDS Operations 43
4.6.4 Decontamination/Packaging/Staging of Contaminated Materials 43
4.7 Full-Scale Mock-Up System 47
5.0 AWR PROJECT SUPPORT SYSTEMS AND COMPONENTS 51
5.1 Distributed Control System 51
5.1.1 System Concept 49
5.1.2 Installation Requirements 49
5.1.3 Utility Requirements 49
5.1.4 DCS Equipment Descriptions 50
5.1.5 Input/Output Nodes 54
5.1.6 Sluicing Nozzle System 58
5.1.7 Bulk Waste Retrieval/CATS System 59
5.1.8 High-Pressure Pump I/O Node 61
5.1.9 TTA I/O Node 63
5.1.10 Decant Pumps 64
5.1.11 TTA Sluicing Nozzle System 66
5.1.12 TTA Bulk Waste Retrieval 66
5.1.13 TTA Building Equipment 66
5.1.14 Radon Control System. 66
5.1.15 Portable Sampling Module 67
5.2 System Components 67
5.2.1 Decant Pump System 67
5.2.2 High-Pressure Pump Skids 69
5.2.3 TTA Decontamination Pump Skid 71
5.2.4 Sluicer System 71
5.2.5 Slurry (Bulk Waste Retrieval) Pump/CATS 74
5.2.6 Hydraulic Power Supply System 79
6.0 REFERENCES 82

000402

INFORMATION ONLY

3157

ACRONYMS AND ABBREVIATIONS

AC	alternating current
ADSS	Arm Deployed Sluicing System
ALARA	as low as reasonably achievable
API	American Petroleum Institute
AWR	Accelerated Waste Retrieval
AWS	American Welding Society
AWWT	Advanced Wastewater Treatment
BRS	Bulk Retrieval System
CATS	Conditioning and Transfer System
CCTV	closed circuit television
CFC	Continuous Function Chart
cfm	cubic feet per minute
CPU	central processor unit
DC	direct current
DCS	distributed control system
DIN	Deutsches Institute Normung
DOE	U.S. Department of Energy
DOF	degree of freedom
DRS	Debris Retrieval System
DWRS	Decant Waste Retrieval System
EDT	EMMA™ Deployment Tower
EMMA™	Easily Manipulated Mechanical Arm™
FDS	Facility Decontamination System
FEMP	Fernald Environmental Management Project
Fluor Fernald	Fluor Fernald, Inc.
fps	feet per second
FSM	Full-Scale Mock-Up
FSMS	Full-Scale Mock-Up System
FSS	Fixative Spray System
GEE	Gripping End-Effector
GEES	Gripping End-Effector System
GFE	government-furnished equipment
gpm	gallons per minute
HEPA	high efficiency particulate air
HMI	human-machine interface
hp	horsepower
HVAC	heating, ventilating, and air conditioning
I/O	input/output
ICAT	Integrated Construction Acceptance Test
ISO	International Standards Organization
MEES	master equipment enable switch
MOV	motor-operated valves
NEMA	National Electrical Manufacturers Association
NIS	not in scope

000403

INFORMATION ONLY

ACRONYMS AND ABBREVIATIONS

NPSH	net positive suction head
PLC	programmable logic controller
PPE	personal protective equipment
Profibus	Process Field Bus
psi	pounds per square inch
RH	relative humidity
RCS	Radon Control System
rpm	revolutions per minute
SAIE	Silo-Arm Interface Enclosure
SDRS	Silo Debris Retrieval System
SFC	Sequence Function Chart
SOT	System Operability Test
SPSA	Sample Preparation and Storage Area
SREE	Silo Retrieval End-Effector
SSC	systems, structures, and components
SWRS	Silo Waste Retrieval System
TEFC	totally enclosed, fan-cooled
TRD	Technical Requirements Document
TTA	Transfer Tank Area
TWRS	Transfer Tank Area Waste Retrieval System
UF	ultra-filtration
UPS	Uninterruptible Power Supply
V	volt
VitPP	Vitrification Pilot Plant
WAC	waste acceptance criteria
WG	water gauge
WT%	weight percent

000404

INFORMATION ONLY 3157

1.0 INTRODUCTION

This System Design Descriptions document provides detailed descriptions of the process systems comprising the Accelerated Waste Retrieval (AWR) Project at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) site. This document includes information from the *Process Descriptions*, Document No. 624-P622-20, for the AWR Project, as well as a description of equipment and instrumentation in each system and the applicable codes and standards for the systems, structures, and components (SSCs) used in the systems. It has been prepared as a component or subset of the *Preliminary Design Package* for the AWR Project, in conjunction with the *Functional Requirements Document* (Document No. 624-P622-02), *Design Criteria* Package (Document No. 624-P622-03), and other AWR Project design submittals.

1.1 Document Purpose and Organization

This System Design Descriptions document describes each AWR Project system in terms of process, equipment, and instrumentation descriptions required to meet the applicable scope of work requirements, including applicable codes and regulations. It is formatted in the following manner. Section 1 provides an introduction that includes the system identification for the AWR Project. Section 2 provides a general overview of the AWR Project that includes the mining strategy of how the waste is retrieved from the silos. Section 3 lists the requirements and bases for design. Section 4 describes each major system design component, with Section 5 describing the distributed control system and system components for the AWR Project. And finally, Section 6 lists the applicable references used in the development of the System Design Descriptions.

1.2 Systems Identification

The AWR Project includes seven major systems listed below.

Silos Waste Retrieval System (SWRS). The SWRS retrieves material from the silos; transfers residues, BentoGrout™, and heel material to the transfer tanks; retrieves and packages discrete objects; and performs gross decontamination of the silos.

Decant Sump Waste Retrieval System (DWRS). The DWRS retrieves materials from the decant sump (liquids from the silos and approximately 1,000 gallons of residue/solids in a heel), segregates materials and transfers/packages them, and performs gross decontamination of the decant sump.

Transfer Tank Area (TTA) System. The TTA system consists of transfer tanks and associated piping and equipment to be used as a storage area for K-65 Material/BentoGrout™ slurry for future transfer to the Future Full-Scale Remediation Facility (not in scope [NIS] of the AWR Project). Provisions will also be made for sampling and sample storage.

Transfer Tank Waste Retrieval System (TWRS). In the future, the TWRS will retrieve the K-65 Material/BentoGrout™ slurry from the TTA and transfer it for processing at the Future Full-Scale Remediation Facility (NIS).

Radon Control System (RCS), Phases 1 and 2. RCS Phase 1 controls and reduces radon concentrations in the silos headspace. RCS Phase 2 ensures radon control during retrieval, transfer, and storage of the silos material.

Full-Scale Mock-Up System (FSMS). A Full-Scale Mock-Up (FSM) Integrated Construction Acceptance Test (ICAT)/System Operability Test (SOT) is to be performed with the Silo 4 FSMS. Foster Wheeler will incorporate the lessons learned from the FSM ICAT/SOT into the AWR Project before beginning operations and use the FSMS for training and troubleshooting during SWRS operations.

Facilities Decontamination System (FDS). The FDS functions to remove gross contamination from the silos, the decant sump tank, and contaminated process equipment as part of facility demobilization and closure. Two categories of gross decontamination activities are provided by the FDS. First, the gross decontamination of silos, decant sump tank, and process equipment, as well as permanent facilities erected during the project is part of the FDS. The second type is decontamination of temporary tools, equipment, and facilities used on the project.

2.0 GENERAL OVERVIEW

INFORMATION ONLY 3157

Silos 1 and 2 contain K-65 material, a residue that contains radionuclides, including radium (the primary contaminant of concern), generated from the processing of high-grade uranium ores. The purpose of the AWR Project is to extract the material from Silos 1 and 2, segregate discrete objects, transfer the residue to transfer tanks for staging before final remediation, reduce the radon concentration in each of the silos' headspace, provide radon control during retrieval and material storage, clean the silos and equipment for system closure, and handle secondary waste generated during the AWR Project.

2.1 Scope

Foster Wheeler is designing, constructing, testing, and directing the operation and maintenance of the AWR Project. Fluor Fernald, Inc. (Fluor Fernald) is providing labor for operations and maintenance. The AWR Project consists of four stages:

Stage 1: RCS Installation, Operation, and Maintenance to reduce the radon concentration of each of the silos headspace before silo retrieval operations;

Stage 2: Demonstration of the FSMS and residue retrieval from the TTA to support processing at the Future Full-Scale Remediation Facility (NIS);

Stage 3: Residue material retrieval from the silos, material segregation, transfer of residue to the TTA, and placement of discrete objects in drums for processing (NIS); and

Stage 4: Staging and storage of the residue in the TTA.

These stages differ slightly than the stages defined in the AWR Project *Technical Requirements Document* (TRD), Document No. 40710-RP-001, prepared by Fluor Fernald, but more accurately reflect Foster Wheeler's approach to managing the AWR Project.

2.2 Mining Strategy

The mining strategy describes how the waste will be retrieved from the silos from a philosophical standpoint as opposed to a procedural and operational standpoint. This information is used to help guide test planning and operational planning for the FSM and actual silo deployment.

2.2.1 Introduction and Purpose

This section provides a general guide towards the development of objectives for safe and cost-effective retrieval of the silo waste. The scope of this section is limited to equipment specifically related to in-tank retrieval; therefore, other important items such as the RCS, the TTA, and many others are not described. The contents of this section do not add, change, modify, or in any way affect the technical requirements of any SSC.

3157

This section also provides a brief introduction to the mining strategy and major equipment that is associated with successfully completing the retrieval operations. While Silos 1 and 2 contain two distinct layers of material that need to be retrieved, the intent is to retrieve them simultaneously. The first layer is a bentonite (trade name BentoGrout™) cap that was placed in the silos to prevent radon migration into the dome space and out of the silos. The bentonite layer varies, but in general, it is approximately 6-inches deep in the center of the silo and 3-feet deep near the silo walls. The material may have dried out on the surface and may still be wetted near the bottom of the bentonite layer. The K-65 ore tailings that were slurried into the tanks are the remainder of the waste that is over 20 feet in depth.

2.2.2 Baseline Modifications

Foster Wheeler evaluated two concepts for retrieval of the waste. The first concept involves selectively removing the bentonite cap and preventing mixing with the K-65 waste material. Storage of the two waste streams occurs in separate TTA tanks. The Silo Retrieval End-Effector (SREE) deployed with the Easily Manipulated Mechanical Arm™ (EMMA™) is used to mine the bentonite, followed by the use of past-practice sluicing techniques for the bulk retrieval and the use of SREE and EMMA™ for heel removal. The second concept starts with past-practice sluicing techniques for bulk retrieval. This method allows the bentonite to mix with the K-65 material and does not violate technical requirements. Upon successful completion of bulk sluicing, the SREE and EMMA™ remove the remaining heel. In both concepts, EMMA™ is equipped with a small arm-based sluicer nozzle to assist in bulk sluicing and wall and floor washdown. Also, EMMA™ reduces in size remaining debris and collects it in both concepts.

After reviewing these concepts, the second concept that allows for the mixing of bentonite and K-65 material combined was selected. The main reason for selecting this option was the minimization of the size of the TTA. Two additional separate tanks for the bentonite material are eliminated. Also, the schedule for the waste retrieval operations is shorter with the second concept as there are essentially five operational phases rather than six.

The current design baseline is to retrieve the bulk waste from the silos using past-practice sluicing, that is accomplished through the use of (1) a low- to medium-pressure, high-volume nozzle through one peripheral riser and (2) a retrieval pump through the second peripheral riser. The Conditioning and Transfer System (CATS) and the retrieval pump are integrated into a single enclosure, thus eliminating two crane lifts. EMMA™ is deployed through the center riser, and it grasps the SREE and maneuvers it within the tank for heel removal and floor cleaning. Upon completion of heel removal, EMMA™ deploys the arm-based sluicer to wash down the walls and the floor. EMMA™ is also used to reduce in size any remaining debris and place it in the debris basket that is deployed through the same riser that the bulk sluicing nozzle was deployed. Early design indicated that the sluicing nozzle enclosure and the Silos Debris Retrieval System (SDRS) enclosure are separate, necessitating lifts off and on the bridge, respectively. Currently, both the sluicer nozzle assembly the SDRS are combined into a single enclosure that requires no lifts from the bridge.

The approximately 1,000 gallons of residue/solids contained in the decant sump tank will be removed by use of the DWRS. This system is separate from the SWRS, and utilizes level instrumentation to ensure the tank level does not exceed 70% of the tank capacity while mobilizing the residues. A closed circuit television (CCTV) camera will be deployed into the

tank to provide the operator visual control. Ventilation of the decant sump tank will be provided through a connection to the RCS.

The residues will be mobilized and the tank will receive gross decontamination by use of a jet tank cleaning system. Twenty gallons per minute (gpm) of water will be supplied to the spray nozzles at approximately 1,000 pounds per square inch (psi) to produce a slurry. The slurry will be vacuumed from the decant sump tank directly to vacuum truck (super sucker). The vacuum truck will be equipped with high-efficiency particulate air (HEPA) filtration, and a discharge pump capable of transferring the slurry directly into the TTA Transfer Storage Tanks. The process of washing, vacuuming, and transferring to the TTA will continue until the decant waste tank is acceptably cleaned.

2.2.3 Retrieval Equipment Descriptions

Baseline descriptions of the retrieval equipment are as follows.

2.2.3.1 EMMA™, Gripper, and Debris Cutting Tool

Three manways in each silo will be modified for the deployment of the SWRS system. The center riser is where the EMMA™ is deployed. The cable-driven EMMA™ is housed in the EMMA™ Deployment Tower (EDT). EMMA™ is equipped with a Gripping End-Effector (GEE) that is used to grasp tools (like the SREE) and support the use of the debris cutting system. The GEE is also used to pick up debris for placement in a debris basket that is lowered through a separate riser. EMMA™ has an integral "small" arm-based sluicing nozzle that provides assistance to the bulk sluicer during bulk retrieval as well as for wall washdown. The arm-based sluicing nozzle is designed to operate at approximately 50 gpm at 200 psi. The nozzle is remotely operated such that a variable spray can be produced that ranges from a fairly coherent stream up to a wide spray pattern. A separate debris cutting system is available for EMMA™ to reduce the size of small pipes and other debris for eventual removal from the silos, using the basket.

2.2.3.2 Bulk Retrieval System - Sluicing Nozzle And Retrieval Pump

The majority (approximately 90%) of the silo waste is sluiced using past-practice sluicing techniques. The Bulk Retrieval System (BRS) consists of two basic components. The first component is the sluicing nozzle that is approximately ¾-inches in diameter and is operated at 150 psi and 300 gpm. The nozzle is remotely articulated to allow for both vertical channel cutting as well as horizontal sweeping as necessary. A simple, hoist-driven system allows the sluicer to be vertically raised and lowered into the silo. The sluicing nozzle and deployment system is housed in one of the peripheral manways. The sluicing nozzle is housed in the same enclosure as the debris retrieval system.

The second half of the BRS is the slurry pump. The slurry pump removes all sluiced slurries from the tank during bulk retrieval operations. The slurry pump is matched to remove waste at the same rates as the bulk sluicing nozzle and arm-based sluicer nozzle operating simultaneously, approximately 350 gpm. The pump is deployed through the third manway located co-linear with the sluicing and EMMA™ manways. The slurry pump is integrated with the CATS enclosure.

2.2.3.3 Heel Retrieval System - CATS, SREE, Conveyance, and Hose Management

The waste that remains in the silos upon completion of past-practice sluicing activities is called the heel. The heel may consist of remaining liquids (i.e., supernatant that is below the net positive suction head [NPSH] of the retrieval pump), soft residue, hard residue, and any agglomerated waste piles and debris. The CATS removes the heel. EMMA™ grasps and maneuvers the SREE in the tank.

The SREE consists of three rotating jets that are used to locally slurry material and direct the slurry to a 2-inch diameter central inlet. The nozzles operate up to a maximum 10,000-psi at approximately 10 gpm. To vacuum the slurry out of the central inlet port, a radial waterjet pump is integrated as close to the SREE as possible. The jet pump requires approximately 10,000 psi of water at approximately 10 gpm. When the SREE inlet is submerged in liquid, the jet pump can remove up to 100 gpm of motive water and liquid. When the inlet begins to pump air, the overall retrieval rate is decreased significantly. However, the system is able to continue to vacuum the bottom of the silo floor.

Both the SREE and the jet pump require filtered water for the small nozzles that are used. The basic premise of the waterjet pump is that three radial waterjets are placed such that they converge in the discharge nozzle of the jet pump, thus creating a vacuum (for a short distance). The slurry from the SREE inlet port is sucked into the three jets and is pressurized and "pushed" through the jet pump discharge nozzle (demonstrated to pump well greater than 60 feet) and into the CATS, which is located as close to the floor as possible. The CATS allows for conditioning of the waste before transfer to the TTA. The CATS monitors the waste level and solids loading in the slurry and adds water if necessary to meet transfer requirements. CATS is additionally used to separate any air from the slurry and exhaust the air back into the silo.

A hose management system between the SREE and the CATS ensures that the heel retrieval hoses do not create undue loading to EMMA™. Hose management is accomplished through a simple cable system to allow for the SREE to be operated within the entire silo floor area.

2.2.3.4 Debris Removal System

A simple basket system design allows the debris that remains at the bottom of the tank to be removed and packaged for disposal. The basket is lowered through the same riser that the sluicing nozzle is deployed. The basket is lowered from the containment housing at the top of the platform by a cable and winch system. EMMA™ uses the gripper to collect and place debris into the basket until the basket is either full or all the reachable debris has been placed into the basket. The basket is raised back into the containment housing where it is placed in a drum to allow for removal from the platform and disposition by Fluor Fernald.

2.2.4 Retrieval Mining Strategy

The retrieval operation occurs in five basic steps. The first step is the bulk sluicing of the K-65 waste and bentonite cap material; the second step is the removal of the heel; the third step is the collection and removal of the debris; the fourth step is wall and dome washdown; and the final step is decant sump retrieval. The first four steps occur on each of the two silos, and the last step occurs only one time upon completion of the silo retrieval.

3157

2.2.4.1 Bulk Sluicing and Retrieval

The sluicing nozzle and the integrated slurry pump/CATS, located approximately 50 feet apart, are used for sluicing the bentonite cap and K-65 waste material. Initially, the sluicing stream is directed as close to the pump inlet as possible to induce a slurry pool for slurry to flow into. Additionally, the slurry pump has the capability to operate in reverse using sluice water to assist in making a slurry pool. The slurry pump also has a high-pressure water jet ring at the pump suction that can blast hard material into pumpable slurry. The sluicing jet, from time to time, will impinge upon and impact the retrieval pump, which is able to withstand the jet during operation. Upon creating the cavity, the nozzle cuts a canyon for slurry to flow through to the pump. The canyon will progress in depth and length toward the sluicer. The slurry pool size at the pump suction will be minimized to minimize free water in the silo. The sluicer will "push" the slurry towards the pump for retrieval. This type of operation occurs as long as it is effective. The width of the canyon will increase with priority being given to increasing the depth of the canyon, and the pump is periodically lowered (remotely) further into the tank until it reaches the bottom.

The sluicing nozzle is also lowered periodically further into the tank. Lowering the sluicing nozzle allows for EMMA™ to be up higher in the tank dome area doing other activities including dome and upper wall washing without impingement by the large sluicing nozzle waterjet. At times, if the sluicing nozzle is inadequate to break up a waste agglomeration, the EMMA™ assists the large sluicing nozzle with the small arm-based sluicing nozzle. This operation allows a focused stream to be applied close to the waste.

The waste stream is monitored to determine the point at which a solids loading in the waste stream is the same as the return supply supernatant. Upon a determination that effective sluicing is complete, the pumping operation is modified to the CATS mode. The bulk sluicing nozzle is retracted back into its containment housing above the silo on the platform.

2.2.4.2 Heel Removal

Heel removal follows the sluicing operation. The heel is defined as anything left over after sluicing is completed. This heel may include slurry, supernate, K-65 material, and debris at the silo bottom. The containment housing of the CATS is an integration of the slurry pump system. The Heel Waste Surge Tank, Hose Bundle, and SREE are lowered through the manway for deployment. The system is then deployed such that EMMA™ can reach and grasp the handles of the SREE. EMMA™ is then used to place the SREE in various locations along the tank floor. EMMA™ also is required to work with the conveyance hose and cable tether to grasp the hose and move it into position for operation at a given location within the silo. The hose is most likely to be lying in the liquid and residue waste.

Initially, the jet pump is turned on, and the SREE (without its cutting jets on) is submerged into the heel to remove all of the free liquid. Then, the SREE jets are activated to slurry and pump any remaining waste into the CATS. The CATS accumulates the slurry in preparation for transfer to the TTA. The exit of the slurry from the conveyance hose is open to CATS to separate any entrained air from the waste. In this manner, there is no net addition of air into the tank; thus ensuring that the RCS is not overcome by additional airflow. The CATS remains in place until all of the walls and floor are washed down and the free liquid removed.

Two methods are possible for operating the SREE. In the first method, slurry pools are created and the SREE is worked around in the slurry pool. The SREE is then moved to another location in the same proximity and a nearby slurry pool is created. This process continues until the slurry pools are eventually merged together. When no further progress is made in one sector, the SREE and hose is moved to another sector where the process is started again until the waste is removed from the silo.

The second method uses the SREE in a more systematic "machining" fashion where "high" points of residue piles are selectively machined to a nearly flat condition. The End-Effector is then moved across the silo floor "machining" off a layer of waste at a time. The slurry pool method is the preferred approach because of the flexibility of the EMMA™ arm, but either method is available.

2.2.4.3 Debris Retrieval

Debris retrieval is accomplished during heel removal. After successful heel removal has been completed, any debris left on the floor of the silo will be removed. The debris consists of small items that cannot be pumped out of the tank as well as larger items such as pieces of pipe.

Large pieces of debris are reduced in size to fit the retrieval basket. Debris is collected and placed in the basket. The debris retrieval system and the debris basket are deployed through the manway for deployment of the bulk sluicing nozzle because all are housed in the same enclosure. A cable and winch lowers the basket and debris-cutting tool into the silo. EMMA™ reaches and grabs the debris-cutting tool and reduces piping pieces to manageable sizes. EMMA™ then sets the debris cutting tool aside and collects the debris and places it inside the basket. EMMA™ washes down the debris and basket, then the wash ring washes the basket as it is retrieved, and the radiation monitoring ring checks the radiation level. The basket is raised back into the containment housing and a remotely operated jib crane moves the full basket into a drum where the basket and contents are sealed and prepared for transport from the platform. Additional baskets are lowered into the silo as needed until all the debris is removed.

2.2.4.4 Wall and Dome Washdown

Wall and dome washing will be occurring partially during sluicing operations. The small sluicing nozzle attached to EMMA™ has a variable geometry nozzle that can be remotely changed and allow for either a coherent jet (for sluicing assistance as described earlier) or in a wide spray to gently and quickly wash down the tank walls, dome, and floor.

2.2.4.5 Decant Sump Retrieval

The decant sump tank is centrally located between and below Silos 1 and 2. The decant sump tank is accessed through a 30-inch corrugated metal pipe which is connected to a 20-inch riser in the tank. During SWRS operations, the decant sump level will be monitored to ensure the liquid level does not exceed 70% of tank capacity. An existing sump pump will be used to remove excess liquids, which will be transferred to an existing onsite tank truck for disposal at the FEMP Advanced Wastewater Treatment (AWWT) facility.

INFORMATION ONLY

3157

As wastes are removed from the silos, the berm surrounding the silos will be lowered incrementally exposing sections of the 30-inch corrugated metal pipe. The corrugated metal pipe will split and cut into pieces as the berm is lowered. The pieces of the corrugated metal pipe will be removed from the silos area and disposed of by Fluor Fernald.

Berm removal will terminate at approximately 16-½ feet above the decant tank. At this point, Foster Wheeler will install a concrete pad with containment curb around the 30-inch corrugated metal pipe. The concrete pad will provide the foundation necessary to support the retrieval equipment. Additional information regarding the DWRS is provided in Section 4.3 of this document.

000413

3.0 REQUIREMENTS AND BASES

The technical requirements and bases for the design of systems and components of the AWR Project are summarized in several project documents, and for that reason, are not specifically provided herein. These AWR Project documents include primarily the *Functional Requirements Document*, Document 624-P622-02, and the *Design Criteria Package*, Document 624-P622-03.

Of note, the basic technical requirements for the system functions, as developed by DOE and Fluor Fernald for the AWR Project and stipulated in Part 7 of the AWR Project contract (i.e., *Technical Requirements Document*), are summarized in the *Functional Requirements Document* for the AWR Project. Similarly, the specific criteria for designing the AWR Project systems and components are summarized in the *Design Criteria Package* for the AWR Project, which also includes the applicable codes and standards used for the design. References related to the AWR Project design are provided in Section 6.0 of this System Design Descriptions document.

4.0 SYSTEM DESIGN DESCRIPTIONS

This section provides the design descriptions for the following AWR Project systems:

- Silo Waste Retrieval System,
- Radon Control System,
- Decant Sump Waste Retrieval System,
- Transfer Tank Area System,
- TTA Waste Retrieval System,
- Facilities Decontamination System, and
- Full-Scale Mock-Up.

4.1 Silo Waste Retrieval System

The SWRS recovers the waste in the silos and transfers the waste to the TTA. The recovery of the waste occurs in three basic steps. The first step is the bulk sluicing of the K-65 waste and BentoGrout™ material; the second step is the retrieval of the heel; the third step is the collection and removal of the debris. Wall washdown occurs as the waste is retrieved. Following Fluor Fernald concurrence that a silo has been cleaned sufficiently as determined by visual inspection by the system cameras, a fixative is applied to the walls and floor of the silo. To provide the global view required to maneuver and control in-silo equipment during waste retrieval and cleaning assessments, three video cameras with lights are deployed through new 12-inch risers located approximately 120° apart at the silo perimeter and independent from the risers used to deploy the SWRS.

The SWRS main systems and components used with each system are:

- EMMA™ System
  - EMMA™ Deployment Tower (EDT) System,
  - Actuation package,
  - Mast, and
  - EMMA™.

- Bulk Retrieval System
  - Sluicer,
  - Sluicer enclosure,
  - Slurry pump,
  - Slurry pump enclosure,
  - Slurry transport piping,
  - EMMA™ System, and
  - Slurry pump.

- Conditioning and Transfer System
  - Silo Retrieval End-Effector,
  - Heel Waste Surge Tank,
  - Conveyance hose management system,
  - EMMA™ System, and

3157

- Slurry Pump.

- Debris Retrieval System
  - Debris retrieval enclosure,
  - Waste size reduction tool,
  - Debris basket and winch assembly,
  - Drum loading station,
  - Debris retrieval spray washer, and
  - EMMA™ System.

4.1.1 EMMA™ System

The EMMA™ System is a major component of the SWRS and is critical to the success of the AWR Project. Two systems are planned for delivery to the FEMP site. These systems will be used for the waste retrieval operations on Silos 1 and 2, as well as the FSM testing activities planned for Silo 4.

The EMMA™ System is designed to assist in mining and silo closure operations from Bento-Grout™ removal through final inspection and fixative application activities. The proposed mining strategy will be achieved through effective employment of the EMMA™. The EMMA™ will facilitate operations from initial entrance into the silo through final clean out, inspection, and closure acceptance. Waste and debris retrieval operations using the EMMA™ System is achieved by:

- Deploying the high-pressure Arm Deployed Sluicing System (ADSS) nozzles to breach the Bento-Grout™ layer and force the dislodged material toward the sluicing pump;

- Forcing the waste and debris away from the sluicing pump and SREE to facilitate continuous operations;

- Deploying the Gripping End-Effector System (GEES) camera and lighting system and ADSS to inspect and clean all wall-mounted silo sampling ports;

- Cleaning the in-silo cameras and lights to ensure optimum visibility for remote operations;

- Transferring debris to different locations in the silo before removal to minimize retrieval obstructions;

- Mobilizing bulk waste and debris from behind the sluicing pump and water cannon;

- Performing wall washing and inspection operations as the headroom within the silo is increased (eliminates need for high-pressure water cannon on walls and minimizes the potential for silo damage caused by high-pressure wall washing activities);

- Forming debris piles for size reduction and removal activities;

- Strategically placing the debris size reduction tool off-center from the riser location near debris piles and providing a flat surface under the silo riser for placement of the debris collection and transport basket;
- Transferring debris from the pile to the size reduction tool to the retrieval basket;
- Providing close visual inspection capabilities throughout operations and final inspection;
- Employing the ADSS for fixative application; and
- Employing the GEES camera and lighting system to assist in initial and final wall, floor, and ceiling inspection activities.

4.1.1.1 EMMA™ Deployment Tower System

The primary purposes of the EDT are to provide containment for the EMMA™ and its support systems during transport, maintenance, and system shutdown, house the mechanical operating systems (i.e., azimuth and z-drives) that provide gross positioning of the EMMA™, and still provide a maintenance and local operating control station area. The EDT is also designed to provide a redundant containment system in the unlikely event of a RCS failure. Additionally, the tower has an integrated airlock system and equipment replacement area. The mounting of the control and power distribution cabinet, as well as the hydraulic pump unit, is done at the tower base. These items will be connected after the erection of the tower and will add area to the system footprint.

The deployment tower structure is a large cylindrical tower made of A36 carbon steel with an airlock room attached to one side of the tower base. The cylindrical structure is a 90-foot tall shell with a wall thickness of 5/16 inches for the lower 20 feet and ¼ inches for the remaining 70 feet. The tower shell provides the structural support and is constructed to provide secondary shielding and containment. Buckling concerns associated with a structure of this magnitude have been addressed through tower bracing. Tower bracing is achieved through ovalling rings placed at 12-foot intervals throughout the tower structure. Each ovalling ring has a 12-foot inner diameter and a 13-foot outer diameter. The disc-shaped ovalling ring is then welded to the outside of the tower at designated points in accordance with American Welding Society (AWS) welding standards. The ovalling rings maintain the circular profile of the structure and prevent shell buckling. Critical calculations have been performed, which are moment load, weight, height, and the center of gravity. Two lifting points are provided – a tailing lug at the base and a trunion at approximately two thirds of the height of the tower.

The tower will attach to the bridge using eight separate bolt patterns equally spaced around a 12-foot, 4½-inch circle at the base of the tower. Each bolt pattern consists of two 1¼-inch bolts located 4½ inches apart. The bolts attach to a base chair design that expands the diameter at the base of the structure to 12-foot, 9-inches.

4.1.1.2 Actuation Package

The actuation package is constructed with American Society of Testing and Materials (ASTM) A500 Grade square tubing. The actuation package's primary purpose is to house the hydraulic actuators and route the cables to their appropriate positions for EMMA™ segment attachment.

The actuation package is divided into two sections, the inner frame and the outer frame. The inner frame rotates inside of the outer frame as it is driven by the azimuth drive.

4.1.1.3 Mast

The mast is a welded truss structure made of various sizes of carbon steel plate tubing that attaches between the actuation package and the EMMA™. The primary function of the mast is to provide rigid support when supporting the EMMA™ as it is deployed into the silo and during in-silo operations. The mast is 13-feet long, weighs approximately 2,000 pounds, and can be accommodated by a 30-inch diameter opening. In addition to supporting the EMMA™, the mast also routes the EMMA™ cables that are fed through the actuation package, and provides a bearing surface against the guide bearing during full insertion of the EMMA™.

4.1.1.4 EMMA™

EMMA™ is a 52 ½-foot long, 30-inch diameter, cylindrical serpentine manipulator composed of five independent stages and a wrist. Each stage contains three segments. Stages 1 through 3 are single degree of freedom (DOF) stages, capable of bending only in a vertical direction. Stages 4 and 5 are two DOF stages, and provide pitch and yaw capability, which allows the stages to bend both in vertical and horizontal configurations. The two DOF wrist at the end of the manipulator provides local dexterity for gripper, end effector, and other special tooling used for silo waste retrieval activities. The wrist and five stages of the manipulator are expected to weigh approximately 7,500 pounds.

The manipulator is designed to operate under the following parameters:

- Operate reliably for 1,000 hours (no scheduled maintenance activities);
- Able to reach the sluicing pump silo when the headroom has reached a height of 23 feet;
- Perform waste retrieval activities in operating temperature ranges of 32 °F to 100 °F with a humidity range of 10 to 100% humidity;
- Manage, as a minimum, a 200-pound payload (includes GEES and ADSS weight);
- Provide a maximum horizontal-reach of 42 feet from on-center riser access location to effectively reach the silo walls;
- Provide a maximum vertical-reach of 42 feet from the bottom of the deployment tower to effectively reach the entire silo floor; and
- Capable of remaining in the silo between operating shifts to minimize insertion/retraction times and maximize in-silo operating periods.

This system, when combined with the z- and azimuth-drives located in the deployment tower, results in a manipulator with sufficient dexterity and lifting capability to carry out operations required for successful mission completion. The manipulator's mechanical behavior is based on the actuation of stages, which are controlled with steel cables and connected via termination

segments. The bending moment is transmitted from segment to segment via elastomeric couplings. There are 5 stages in the manipulator that has 9 total segments. Stages 1 through 3 are constructed from a single segment. Stages 4 and 5 are constructed from 3 segments. For Stages 4 and 5 when a single stage is actuated, the three segments in the stage go through similar motion. Also, the motion of Stages 1, 2, and 3 are coupled, and putting stage 3 in motion also applies force to Stages 1 and 2 which puts them in motion. Also, putting Stage 2 in motion would put Stage 1 in motion, but would not affect Stage 3. This design reduces the force requirements of the actuators for the first three segments.

The drive cables for Stages 4 and 5 are isolated from the previous stages by conduit, thus actuating these stages does not affect the previous stages other than changing the transmitted movement due to gravity. The drive cables for Stages 1, 2, and 3 are not housed in conduit, so the forces applied to one stage are transmitted back to the previous stages. This design reduces the overall cable tensions required to lift the manipulator, but also requires the use of back-tension to prevent undesired motion of previous stages. This design reduces the overall cable tensions required to lift the manipulator, but also requires the use of back-tension to prevent undesired motion of previous stages.

Manipulator Segment Components—The segments contain cable routing bushings, bushing mounting fittings, and connection fittings. The cable routing bushings are constructed of hardened steel to reduce wear on the bushing surfaces as the actuation cable passes through the bushing. The bushing mounting fittings provide ease of assembly and maintenance. These fittings are affixed to the exterior of the segments, and allow easy cable removal and insertion. These fittings transfer the load from the cables to the structural components of the segments. The connection fittings enable the transfer of both compression and torsion.

Stages 1 through 3-The first three stages of the manipulator provide the basic positioning and major lifting capacity of the system. These stages are rather specialized in that they are designed only to provide motion in one direction (1 DOF). Stages 1, 2, and 3 are 132 inches and each weighs approximately 1,000 pounds.

Stage construction is accomplished through a thick curved backplate and an aluminum honeycomb structure. This construction provides support against the guide bearing and is resistant against the shear, compression, and torsional forces experienced in the segments. Plates at the end of the segments contain the bushings and hinges that are used to link stages, attach cables, and rout cables through the segments. Umbilicals, conduit, and cable for stages and end tooling located farther down the arm are routed through the sides of the segments. This area is accessible through hatches in the outer shell of the segments.

Stages 1, 2, and 3 use revolute joints that restrict movement to one DOF. A hard stop will limit the rotation between an angle of 0° and 45° (or 60°) with respect the to vertical axis. As a result, the stage can only bend in one direction and cannot reverse its direction of bend as is possible in the universal stages (Stages 4 and 5). This design significantly simplifies the kinematics of the system and allows for more accurate tracking of the position of the first three stages. This design also allows for the addition of simple and robust encoders on the manipulator that will further increase the accuracy of the forward kinematics calculations.

No conduit is used in the first three stages, so cables actuating distal stages affect the dynamics of the preceding stages. Termination segments for proximal stages act as pass

through segments for more distal stages. The result is that the more proximal cable sets do not need to pull with as much force because distal cable sets are supporting a significant amount of the weight of the manipulator. However, proximal cable sets will be sized to support the full weight of the system in the event of a cable failure.

Stages 4 and 5-While Stages 1, 2, and 3 are intended to provide the basic positioning of the manipulator, Stages 4 and 5 are designed for finer positioning of the end effector. These stages are intended to bend in all directions and are isolated from other stages through the use of conduit. Stages 4 and 5 of the arm use elastomer two DOF couplings to provide the bend in the stage. Unlike the joints in Stages 1, 2, and 3, these couplings are free to bend in any direction. These stages rely on the flexing of elastomer cylinders to provide bending capabilities. The use of conduit effectively isolates the cables used to drive these stages from the motion of the previous stages. Stages 4 and 5 do not aid in the lifting of any of the other stages.

Wrist-The wrist sockets into the termination segment of Stage 5. The cable assemblies are routed through the length of the manipulator and finally into the central segment member where they meet the main portion of the wrist. The wrist provides roll and pitch motion for the GEES. A flexible protective covering (sheath) will surround the wrist and protect the gripper umbilicals. Additionally, the umbilical section at the wrist will be fitted with quick-disconnects for easy replacement. The wrist is designed in accordance with the following design criteria:

- Maneuver, at a minimum, a 200-pound payload;
- Provide roll motion of up to ±180°;
- Provide pitch motion of up to ±60°;
- Withstand the radiation and humidity expected in the silo environment; and
- Withstand operations in temperature ranges of 0 °F to 110 °F.

The wrist design will include two electrical motors that use a gearbox to provide the drive for the roll and pitch axes. This design will provide the torque and speed requirements of the application, and will be protected from the silo environment through the use of a sheath. A device that can de-couple the motor from the roll and pitch axes will be used to ensure that a wrist position that will allow for the extraction of the EMMA™ from the silo in an emergency situation can be maintained. The roll of the system uses a slip key system, which will easily allow for the ±360° rotation. Electrical trigger switches will be used for the end of travel. Drives for the electrical motors will be contained in the actuation package.

4.1.2 Bulk Retrieval System

The majority (approximately 90%) of the silo waste is removed by sluicing using the BRS. Bulk retrieval of the silo waste material is accomplished by a sluicing nozzle and a slurry pump (these items are approximately 50-feet apart in the silo). The operators to the systems' control valves are electric and controlled normally from the control trailer and also from local control panels. Sluicing fluid comes from the TTA Decant Pumps.

L - 3157

Initially, the sluicing nozzle is directed as close to the Slurry Pump inlet as possible to create a slurry pool (6-foot diameter by 1½- to 3-feet deep) and form a cavity for slurry to flow into. The Slurry Pump is lowered into the cavity and turned on when sufficient submergence has been achieved. Additionally, the sluice water can be directed to the slurry pump and the pump operated in reverse to assist in developing a slurry pool, as well as to backflush the screened intake. The slurry pump also has a high-pressure water jet ring at the pump suction that can blast hard material into pumpable slurry. The sluice nozzle then begins cutting a vertical "canyon" into to the silo waste, pushing it towards the pump. The width, depth, and length of the "canyon" will be increasing while trying to minimize the diameter of the slurry pool around the slurry pump (see Section 2 of this document for Mining Strategy details). After each day's sluicing operations, the slurry line, slurry pump, sluicer line, and sluicer are back flushed with decant water then rinsed with filtered water. If plugging occurs during normal operations, the decant water.

As the waste in the silo is lowered, the slurry pump is periodically lowered further into the tank, until it reaches the bottom. As the pump is lowered, liquid-level instrumentation mounted on the pump is monitored to ensure proper submergence before the pump is started to avoid cavitation and minimize plugging. The pump is also fitted with a lower travel-limit switch that prevents it from being driven into solid K-65 material.

The pump has a discharge pressure gauge and a Coriolis effect mass flow meter. The mass flow meter measures the slurry mass flow rate and density. It is equipped with a "net flow" computer that converts instrument measurements into a total mass of solids transferred through the slurry line. The mass flow rate and density measurements are used to maintain the critical solids loading in the slurry line. The measurements are necessary to ensure the slurry transfer pipeline flow is in the turbulent flow region to prevent plugging. The accuracy of the flow meter at the nominal process solids loading (10 to 20 weight percent [WT%]) and volumetric flow rate (300 to 350 gpm) is estimated at ± 0.11%. If the solids WT% increases either sharply or indicates an increasing trend, then sluice water is injected directly into the slurry transfer line to maintain the target solids content and to help ensure solids do not settle in the transfer piping.

The sluicing nozzle is also lowered periodically as the waste level is decreased. Lowering the sluicing nozzle allows EMMA™ to operate freely in the upper tank dome area and perform other tasks like dome and upper wall washing without being impacted by the large sluicing nozzle waterjet. Lowering the nozzle also increases waste mobilization efficiency by attacking the waste at a more direct angle and shorter distance. The sluicing flow is matched with the slurry pump discharge rate to achieve a steady state of slurry in the silo. The normal operating range is between 300 to 350 gpm. The sluicer is equipped with pan and tilt capability for fine control of angle of attack.

There may be times that the sluicing nozzle is not adequate to break up the waste. The EMMA™ assists the large sluicing nozzle with its smaller (½-inch) sluicing nozzle integrated into the arm. This design allows a focused stream to be applied close to the waste. EMMA™ has a second nozzle set for a wide spray to gently and quickly washdown the tank walls, dome, and floor. The fluid for this sluicing and washdown comes from the TTA filtrate storage tank using the high-pressure pumps. The sluicing operation continues until the Slurry Pump can no longer continue pumping slurry because of head limitations or cavitation occurs because it is at the silo floor.

3157

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4.1.2.1 Sluicer

The sluicer nozzle is approximately ¾-inches inside diameter and is normally operated at 150 psi and 300 gpm that creates a sluicing stream velocity of approximately 140 feet per second (fps). The nozzle is remotely articulated from the AWR Project control trailer in an automatic or manual mode to allow for either vertical channel cutting or horizontal sweeping as necessary. The sluicer has a ±170° horizontal rotation and a +100° and -5° vertical rotation capability from the six o'clock position. As the level of the waste decreases, the sluicer is lowered to achieve the proper angle of attack on the waste. Sections of mast containing sluicing piping are manually added with the assistance of a hoist to raise and lower the nozzle. The fine adjustment of the nozzle elevation is accomplished by the mast hoist in the sluicer enclosure. The mast hoist is normally operated from the AWR Project control trailer, but may also be operated locally when adding or removing sections.

4.1.2.2 Sluicer Enclosure

The sluicing deployment system is housed in a Sluicer Enclosure. The enclosure measures approximately 6-feet by 10-feet by 20-feet high. The enclosure serves as secondary containment and drains to the silo. The enclosure weighs approximately 15,000 pounds and has several gloveport panels, an 11-feet by 3-feet access door and a 2-feet by 2-feet pass-through. The weight of the sluicing system is supported off the silo bridge platform. The sluicing system is connected to the silo by a flexible coupling or bellows that allows for small vertical or horizontal bridge platform movement without inducing stresses to the silo.

When the sluicer is no longer needed, it is removed from the silo while being decontaminated by a high-pressure spray ring that is mounted on top of the riser flange then passed through a radiation monitoring ring. Manual washing with a spray wand occurs through the glove ports as the equipment is removed to ensure the equipment is properly cleaned. Water to the spray ring and manual spray wand is filtered water and comes from the high-pressure decontamination pump. The sluicer has a large interface flange on one end for mating to the SDRS. During sluicing, the interface opening is covered by a panel. After sluicing, the panel is removed and the SDRS is bolted to the sluicer interface flange. The sluicer mast sections are stored and the mast support table is unbolted and moved away from the silo riser opening allowing the SDRS to access the riser for its retrieval operations.

4.1.2.3 Slurry Pump

The slurry pump is a progressive cavity pump with a capacity of 500 gpm of water at 100 psi of discharge pressure. Normal operation of the pump is expected to be approximately 350 gpm and 80 psi. The pump is approximately 13-feet long, including gear motor drive, with vertical profile dimensions of 19.5-inches by 15-inches. The pump weighs approximately 2,300 pounds. The pump housing is cast iron. The stator is Buna-n and the rotor is hard-coated stainless steel. A strainer basket is mounted on the suction of the pump with a ½-inch mesh size. The pump is supported from one or two 12-foot-long mast sections. The mast sections contain piping or hoses for the slurry discharge, flush water, SREE utilities, and heel waste retrieval jet pump. The drive motor is variable-speed (0 to 250 revolutions per minute [rpm]) and approximately 50 horsepower (hp). The motor and pump assembly is mounted on a vertical-positioning table that is raised and lowered by an open loop, remotely controlled, single-speed alternating current (AC) drive motor. When the pump is lowered to the bottom of the

table's travel, the assembly is manually secured and disconnected from the table; the table is raised and a new section of mast is installed. A level instrument remotely displays the table's elevation. The pump has liquid-level and lower travel-limit instrumentation that indicates when the pump has been adequately submersed in the slurry to avoid cavitation and prevents driving the pump into solid K-65 material. The total weight of the slurry pump system, support equipment, and enclosure is estimated at approximately 18,000 pounds.

4.1.2.4 Slurry Pump Enclosure

The slurry pump deployment assembly is housed in a Slurry Pump Enclosure. The enclosure measures approximately 9-feet wide by 18-feet long by 20-feet high. The enclosure serves as secondary containment and drains to the silo. The enclosure has a horizontal sliding carrier that assists with pump and mast section assembly, and stowage. The enclosure has multiple gloveport panels, a 10-foot by 3-foot access door, and a 2-foot by 2-foot pass-through. The enclosure is designed to store the slurry pump equipment and is used as containment while transferring the equipment between the silos and to the TTA tanks.

The weight of the Slurry Pump System is supported off the silo bridge platform. The Slurry Pump System is connected to the silo by a flexible coupling that allows for vertical or horizontal bridge platform movement without inducing stresses to the silo. When the slurry pump is no longer needed, it is retracted from the silo while being decontaminated by a high-pressure spray ring that is mounted at the bottom of the enclosure. Manual washing with a spray wand and radiation monitoring occurs through the gloveports as the equipment is removed to ensure the equipment is properly cleaned. Water to the spray ring and manual spray wand is filtered water from the high-pressure decontamination pumps.

4.1.2.5 Slurry Transport Pipeline

The slurry transport pipeline is routed overhead from the waste silos to the TTA. The slurry transport pipeline is a pipe-in-pipe design that provides secondary containment. The slurry transport pipeline is provided with freeze protection and instrumentation to detect leaks into the secondary containment, and monitor pressure drop and slurry density. The slurry transport volumetric throughput is designed to maintain a minimum velocity to deter solids settling. The pipeline is sloped to the TTA from the Support Bridge to allow self-draining.

The slurry transport pipeline terminates at a diverter valve containment area centrally located to the waste storage tanks and the slurry is discharged into the TTA storage tanks. If plugging occurs during normal operations, then the decant water to the sluicers is directed into the slurry line to clear the blockage. Capability is provided for forward flush and back flush to clear a clogged line. In addition to flushing capability, clean-outs are provided in the transfer piping at intervals of approximately every 80 feet between the Silo Bridge and the TTA. A spare slurry transfer line is also provided which will enable operations to continue until the end of the operating period. Pressure gauges located at intervals along the transfer piping for use in determining the location of the blockage.

Once the approximate location of the blockage is pinpointed, the clogged transfer line will be breached, during shutdown, at one of the clean-outs. A containment field will be established to ensure the containment of any liquids or residues, and the blind flanges on the containment pipe and carrier pipe will be removed. A manually operated metal "snake" will be deployed by

maintenance personnel wearing personnel protective clothing and respirators, as determined by health physics, to clear the clog.

Since the slurry pump is equipped with an inlet screen to minimize the size of debris, the clog will most likely consist of K-65 and BentoGrout™ material. This material will remain in the pipe, and be flushed to the Transfer Tank after the blockage has been cleared. The maintenance personnel will wipe the metal "snake" with a cloth and allow the residues to fall into the carrier pipe. The cloth will be bagged and disposed as contaminated waste, and the metal "snake" will be either bagged for disposal, or bagged and taken to a decontamination area for cleaning. Following this procedure, the system will be closed and aligned for flushing with decant water, thus transferring the material to the TTA Transfer Tank.

4.1.3 Conditioning and Transfer System

The waste that remains in the silos upon completion of the bulk retrieval process is called the heel. The heel may consist of remaining liquids, decant that is below the NPSH of the slurry pump, soft residue, hard residue, and agglomerated waste piles. The CATS consists of a heel tank and slurry pump assembly, SREE, hose management system, and EMMA™ System.

When bulk retrieval is complete, the slurry pump is removed from the silo. A SREE cradle is manually lowered into the silo and placed on the bottom by EMMA. With the pump removed, the pump inlet screen is replaced with a cap that creates a heel waste surge tank. The SREE is then attached to the end of the CATS hose bundle and is lowered down the slurry pump's riser. The jet pump is then installed into the hose bundle. The hose bundle hoses are connected to the heel waste surge tank before it is inserted into the silo. The slurry pump tank assembly is then lowered until it reaches the bottom of the silo. The sluicer from the BRS is removed and an SDRS is installed in the riser. The SREE is grasped by the EMMA™ gripper and manipulated to mobilize and remove the remaining heel. A waterjet pump provides the motive force to pump the waste through the discharge hose and into the heel waste surge tank. The water for the jet pump and SREE comes from the filtrate storage tank using the high-pressure pumps. Approximately 200 to 250 gpm of sluice tank water is directed into the heel waste surge tank and comes from the decant pump. When the jet pump is started, the slurry pump is turned on and the waste is transferred to the TTA tanks.

A continuous flow of sluice water is maintained into the surge tank to ensure that the slurry pump maintains a continuous flow through the slurry transport line at the appropriate velocity to minimize potential for line plugging. The water and waste added to the hopper by the SREE and waterjet are then transported by the slurry pump along with the sluice water flow. The heel waste surge tank uses the same level detection device used by the slurry pump during bulk retrieval. This level data is used by the operator to maintain the tank level by adjusting the slurry pump speed. When the heel removal activities are completed for the day, the slurry pump, the slurry line, decant line, and SREE are flushed with decant water and then rinsed with filtrate water.

4.1.3.1 Heel Waste Surge Tank

The heel waste surge tank receives the waste from the SREE and the decant supply line to vent out the air that was entrained in the waste mixture from the SREE and jet pump. The heel waste surge tank has approximately a 200-gallon capacity and is located under the slurry pump

to create a reservoir from which the slurry pump can pump. The tank is equipped with level instrumentation, sluice water addition, slurry pump suction piping, and a vortex plate.

When the heel has been removed, the surge tank, slurry pump, and mast sections are removed from the silo while being decontaminated by a high-pressure spray ring that is mounted at the bottom of the slurry pump enclosure. Manual washing with a spray wand and radiation monitoring occurs through the gloveports as the equipment is removed to ensure the equipment is properly cleaned. Water to the spray ring and manual spray wand comes from the high-pressure decontamination pump.

4.1.3.2 Silo Retrieval End-Effector

The SREE consists of three rotating jets that are used to locally slurry material and direct the slurry to a central inlet that has a 2-inch diameter. The nozzles operate at up to a maximum 10,000 psi at approximately 10 gpm. Water to the nozzles comes from the SREE high-pressure pump. To vacuum the slurry out of the central inlet port, a radial waterjet pump is integrated as close to the SREE as possible. The jet pump requires approximately 10,000 psi of water at approximately 10 gpm. Water to the nozzles and jet pump comes from the SREE high-pressure pumps. The basic premise of the waterjet pump is that three radial waterjets are placed such that they converge in the discharge nozzle of the jet pump, thus creating a vacuum (for a short distance). The slurry from the SREE inlet port is vacuumed into the three jets, at that time it is then pressurized and "pushed" through the jet pump discharge nozzle and into the heel waste surge tank.

A flexible skirt design is used on the SREE to confine spray when operating on hard surfaces at higher pressures during final floor cleaning. This design reduces mist generation and its impact on performance of visual surveillance systems. The SREE has flow passage geometry and a vacuum relief to maintain airflow in the event of a plugged inlet, thereby preventing settling in the conveyance line. The conveyance line has backflush capabilities to clear any plugs.

4.1.4 Silo Debris Retrieval System

When the bulk waste retrieval is complete and the heel retrieval process is underway, there will be debris such as plastic bottles and metal pipe sections at the bottom of the silo. The SDRS removes this waste.

The debris will fall as the waste level falls and will be left on the silo floors. The in-silo SDRS consists of a steel cage basket and hydraulically actuated waste size reduction tool. EMMA™ places large debris, such as pipes that will not fit in a debris basket, into the waste size reduction tool. Following size reduction, EMMA™ places the smaller pieces into a debris basket. The basket is washed using the EMMA™ spray nozzle, lifted into a decontamination spray ring station, passed through a radiation-monitoring ring, and lifted into a packaging enclosure. If the debris is not sufficiently decontaminated, then a second washing in the spray ring or manual wand washing is executed.

The baskets are then raised into the SDRS enclosure, where they are automatically loaded into 30-gallon drums by a hoist system. When a drum is filled, a worker in appropriate personal protective equipment (PPE) enters the SDRS enclosure to seal the drum. The entire process is automated except for the final tightening of the 30-gallon drum lid bolt and the installation of a

new 30-gallon drum in the enclosure load-in station. One end of the SDRS enclosure has a flanged interface opening covered by a removable panel. When sluicing is finished, the panel is removed and the SDRS is mated to the sluicer to allow access to the sluicer's silo riser.

4.1.4.1 Waste Size Reduction Equipment

The waste size reduction equipment consists of water hydraulic-powered shears. The hydraulic power supply remains in the debris removal system enclosure and the shears are located in the silo. Operation of the cutting device is performed remotely from the control station.

4.1.4.2 Silo Debris Retrieval System Enclosure

The debris removal system enclosure houses the lifting hoists, manual spray wash station, 30-gallon packaging equipment, and all waste removal support equipment. The enclosure serves as secondary containment and drains to the silo. The enclosure is supported by the Silo Bridge and connects to the silo by a flexible coupling or bellows through the same opening as the sluicer.

The SDRS enclosure is fabricated from a standard 20-foot International Standards Organization (ISO) container modified with double doors for ease of ingress and egress. The doors are airtight. A tele-operated ½-ton hoist assembly is installed onto the roof of the container. Racks and clips are provided to hold the debris baskets and drums in position.

4.1.4.3 30-Gallon Drum Packaging Equipment

The packaging equipment consists of a hoist system that offloads the waste baskets into a 30-gallon drum. This system is fully automatic except for unloading of a full drum from the silo, loading of a new drum in the load-in station, and clamping the lids on the containers. A grasping bridle mechanism will grasp the top ring of the baskets. This design allows the winch bridle to pick up an empty basket and set it into the drum after filling. The bridal mechanism is also designed on the top to prevent anything catching on the manway protective cover as the basket is hoisted up. The waste basket is steel mesh and not reusable. A new basket is used for each retrieval effort. A pan and tilt camera mounted on the wall provides full-room coverage, and a second camera mounted on the hoist provides the view necessary to see down the manway and into the basket.

4.2 Radon Control System

The RCS is a treatment system that employs air conditioning, dehumidification, activated carbon, and HEPA filtration to reduce the activity of radon in Silos 1 and 2 and the TTA tanks for the AWR Project. The major process components are located within buildings at the FEMP site. Auxiliary components are located on a pad outside the RCS Building. The RCS receives gas streams from the following sources:

- Silos 1 and 2 (including during decontamination of the silos),
- Silo Waste Retrieval System,
- Decant Sump Waste Retrieval System,
- TTA System,
- Transfer Tank Area Waste Retrieval System, and

- Future Full-Scale Remediation Facility.

The RCS is designed to remove radon-laden air from the various system components, reduce radon releases to the atmosphere, detect and measure releases to the atmosphere, and mitigate system upsets. Contaminated gases removed from the sources described above are drawn through the RCS by redundant centrifugal fans. The fans and ducting system are designed to prevent over or under pressurization of the silos and transfer tanks beyond +0.5 inch water gauge (WG) and -2.0 inch WG. The ducting system recirculates process air through the system or discharges through the exhaust stack, while maintaining the required silo and tank pressures. The ducting system is balanced using a redundant programmable logic control (PLC) system that monitors the prevailing pressure and volumetric air flow conditions. The control system automatically controls fan speeds and the damper system. The automated damper system discharges air from the system, draws fresh air into the system, and isolates process areas, as required to maintain the appropriate operating conditions. The fans are located downstream of the carbon beds to maintain an induced draft in the carbon beds. The ducting arrangement, in conjunction with the automated monitoring and damping system, prevents backflow of contaminated gases to the atmosphere.

The total design flowrate for the RCS is 1,000 cubic feet per minute (cfm). The ventilation rate for each source listed above is dependent upon which operational phase is in effect for the RCS. The ventilation gas from each source is withdrawn and transferred to the RCS Building where the treatment equipment is located. Ventilation air from each source is combined into a 10-inch insulated, carbon steel, common duct header equipped with a gravity drain trap connection that discharges to the Condensate Holdup Tank (TNK-20-002B). The 10-inch duct header connects to redundant 95%-efficient roughing filters (FLT-20-001A and FLT-20-001B) for particulate removal. Filter housings for the roughing filters are stainless steel, side access, bag-in/bag-out type housings rated at 1,000 cfm each. Filters will be operated with one online at a time dependent upon which train is in operation.

Upon exiting a roughing filter, the ventilation air enters one of the redundant desiccant drying systems (DDS-20-001A and DDS-20-001B) at 90 °F and 100% relative humidity (RH) where the air stream is cooled and dehumidified to 36 °F and 15% RH. The gas is cooled and dehumidified to enhance the dynamic adsorption capacity of the activated carbon. Each desiccant drying system consists of a pre-cooling coil, regenerative desiccant wheel, post-cooling coil, closed loop reactivation system, and a condensate collection and transfer system housed in an aluminum cabinet housing. Each system is rated at 1,000 cfm. The pre-cooling coil cools and dehumidifies the ventilation air to a stream that is 55 °F saturated air. From the pre-cooling coil, the air flows through a desiccant wheel where the air is dehumidified. The temperature of the air exiting the wheel will be 98 °F with moisture content of 5 grains per pound. Ventilation air from the desiccant wheel flows through a post-cooling coil where the air is cooled to the target temperature of 36 °F before exiting the desiccant drying system.

Chilled water cooling streams for the cooling coils within the desiccant drying system are provided by a set of redundant 50 ton reciprocating chillers (approximately) located outside the RCS Building. The chillers are equipped with the necessary expansion tank, air vents, air separators, and chilled water supply pumps to provide the necessary chilled water flows. Three-inch, carbon steel, chilled water supply and return lines are used to transfer the cooling media to and from the coils within the desiccant dryers. The desiccant wheel has a closed-loop reactivation system for regeneration of the desiccant. This reactivation system includes a

blower, heater, and condensing coil. Redundant chilling/desiccant systems are provided to ensure continuous availability.

A condensate pump located within the desiccant drying system transfers condensed liquids from the desiccant drying system to one of two 3,000-gallon carbon steel hold-up tanks (TNK-20-002A and TNK-20-002B). The condensate holdup storage tanks are vented to the RCS and will open to relieve pressure. These tanks are equipped with vacuum control valves to let air into tanks when vacuum setpoint is reached. The liquid is held for as much as 40 days in the condensate holdup tanks to allow for radon decay. Subsequently, transfer pumps (PMP-20-001A and PMP-20-001B), which are made of ductile iron and rated for 25 gpm at 40 total displacement head (TDH), dispositions the liquid in one of two ways:

1. Transfer to the filtrate tanks in the TTA building for subsequent distribution to one of the four Transfer Storage Tanks or use by the high-pressure pumps.

2. Transfer to the FEMP Advanced Wastewater Treatment (AWWT) facility after characterization indicates the condensate meets the waste acceptance criteria (WAC).

The chilled/dehumidified ventilation air stream exiting the desiccant drying systems flows to the carbon adsorption units (CBD-20-001A, CBD-20-001B, CBD-20-002A, and CBD-20-002B) via a 10-inch carbon steel duct header. The carbon adsorption system consists of four insulated carbon steel vessels, approximately 16-feet by 11-feet by 11-feet, which contains a total of 160,000 pounds of carbon (40,000 pounds per vessel). The four carbon beds are operated in parallel splitting the flow equally. Each carbon bed is connected to the 10-inch main duct headers by 8-inch branch duct connections on both the inlet and outlet of the beds. Each bed is aligned with a dedicated inlet and outlet damper for flow control and isolation. Modulating dampers and flow elements provided on the inlet of each bed allow flow to each bed to be reduced or increased on the basis of operations. Each carbon adsorption vessel shall be capable of treating up to 500 cfm.

Ventilation airflow rates and sources vary during different phases of RCS operation. The modulating dampers provide for flow distribution among the beds. Each carbon bed is physically isolated in an individual room. The treated air stream from each carbon bed is monitored individually for radon. In the event that elevated levels of radon are detected downstream of a carbon bed, adjusting the automatic air damper on the inlet side of the carbon bed will reduce the airflow through the affected bed. If performance of the bed continues to degrade, then the motor operated damper downstream of the affected bed will be closed automatically and the airflow will be redistributed through the other carbon beds.

In the event a carbon bed needs to be dried, the RCS has the capability to isolate the individual bed from the others. A take-off stream from the recirculation fans will be heated using an inline process heater (DHT-20-001) and passed through the affected carbon beds using and induced draft fan (FAN-20-003) which is a single stage, constant speed, centrifugal type fan with a carbon steel housing. The fan is rated at 500 cfm at 15 inches total static head. From this fan the drying air stream is transferred to the RCS for treatment in the carbon beds that remain on line or if the bed is allowed to sit until the radon has decayed adequately, there exists the capability to discharge through the HEPA filters (FLT-20-002A and FLT-20-002B).

The treated gas stream flows from the carbon adsorption units through 8-inch branch connections to the 10-inch duct header to the redundant HEPA filtration units (FLT-20-002A and FLT-20-002B). Filter housings for the HEPA filters are stainless steel, side access, "bag-in/bag-out" type housings with in-place test sections. The HEPA filtration system employs bag-in and bag-out features to minimize the potential of releases during filter changes. Filters will be rated at 1,000 cfm each and operated with one online at a time. Air from the carbon beds, makeup air, and fan recycle combine before entering the HEPA filters.

A tee in the flow path before the exhaust fans provides makeup air to the closed air system through damper LVR-20-015. Damper LVR-20-020 allows recycled air back to the active fan. This configuration allows the fan to run near its rated speed (in rpm) to reduce strain and thus potential maintenance on the system. A tee in the flow path after the exhaust fans allows excess air to exit the system to the stack through damper LVR-20-016.

This configuration allows the flow path of the air to:

- Return to the silos or TTA tanks,
- Be exhausted to the stack,
- Be modulated to reduce total flow through the entire system, and
- Allow fresh air makeup to take place.

Quantities of makeup air and fan recycle air will be based maintaining a certain static pressure at the discharge of the fan. After exiting the operating HEPA filter unit the treated air stream enters the operating recirculation fans (FAN-20-001A and FAN-20-001B) for redistribution to the silos, TTA tanks, or exhaust through the monitored stack (STK-20-001). The recirculation fans are single stage, variable speed, centrifugal type fans with a carbon steel housing. The recirculation fans are rated at 1,000 cfm at 50 inches of total static head.

Air from the recirculation fans can be recirculated to the silos, TTA tanks, or exhausted through the stack. Air that is to be recirculated back to the silos or the TTA or exhausted out the stack is sent through a common duct header. Air recirculated back to the silos or the TTA is sent through a duct located on the pipe rack that branches to each of the areas and further branches to the individual silos and tank sources to supply the recirculated air to each one. The distribution of air being exhausted versus the amount of air being recirculated to the different sources is controlled by using modulating dampers LVR-20-016, LVR-20-015, and LVR-20-020 which will be controlled based upon pressure in the fan discharge line. The pressure in the fan discharge line will be affected by the pressure in the silos and TTA tanks, each of which has modulating dampers on the inlet and outlet lines of the silos and TTA tanks for pressure control within each source vessel.

The stack is a 150-foot tapered carbon steel stack that is approximately 6 ½ feet at the base and tapers to approximately 3 feet at the top. The maximum airflow through the stack is 12,000 cfm. The stack has connections for a 10-inch carbon steel RCS process duct and a 34-inch carbon steel building ventilation duct. The stack is provided with an isokinetic sampling system and will include monitoring for both particulate radionuclides and continuous monitoring for radon. In the event that an out-of-parameter condition is detected, an alarm is enunciated and appropriate action is taken, such as switching the HEPA filters being used, recirculating the process flow to the silos, reducing the airflow in the RCS, or shutting down the RCS. In addition to the automatic actions taken by the control system, the system calls—using telemetry—a

designated number to alert the on-call responsible person that an out-of-parameter condition exists.

The RCS PLC is provided with software that is compatible with the overall process control system through a networking software package (e.g., Siemens PROFIBUS or other suitable technology). The RCS PLC human-machine interface (HMI) computer exhibits the following software capabilities:

- Scanning the input/output (I/O) signals received by each of the individual unit operations,
- Providing input data to registers at each individual unit operation controller to enable or disable control functions at the respective unit operation controller, and
- Providing graphic screens that display the relevant operating parameters and status of the individual unit operations controlled by the RCS PLC, as well as the complete process control system as a total.

The PLC programming is designed to:

- Automatically monitor and control the unit operations within the RCS operating system to ensure correct operating conditions are maintained,
- Automatically switch between redundant process trains when operational, maintenance, or mechanical problems occur,
- Initiate carbon bed isolation and/or recirculation mode upon detection of an out-of-parameter radon level from radon monitoring instrumentation,
- Enunciate warning status alarms to inform operational personnel that conditions exist within acceptable design parameters but outside desired operating conditions, and
- Enunciate emergency status alarms and automatically initiate system shutdown if conditions exist that are outside design parameters (e.g., unrelieved high-pressure in silos).

Alarms are enunciated at both the local PLC interface and at the overall process system control interface. Backup power is provided by an Uninterruptible Power Supply (UPS) to control system components to ensure uninterrupted operation.

The RCS Building has a partial second-story and a nominal footprint of 30-feet by 135-feet. Outside the RCS Building, there is an exterior pad upon which the set of redundant chillers is installed. The RCS Building is separated into two areas, one containing the carbon beds and one containing the process equipment.

A concrete partition wall that is 24-inches thick separates these two areas. The air conditioning area contains the roughing filters, desiccant drying systems, condensate hold-up tanks, and condensate transfer pumps associated with the cooling and drying operations that are being performed in this area. The air conditioning process train is redundant to allow for maintenance

activities on one train while the other operates. Two 24-inch concrete shielding walls separate the air conditioning process trains (desiccant drying systems). Also, a 12-inch slab is positioned over the desiccant drying system for shielding purposes. The operation of equipment located within the air-conditioning vaults will be cycled on the basis of maintenance, mechanical, and operational considerations. The carbon bed area is shielded by 24 inches of concrete. The air conditioning areas are shielded by 12 inches of concrete.

Space is provided to perform maintenance on equipment. A nominal 1-foot of concrete shielding is provided between each set of redundant equipment to account for radon that may be absorbed and trapped in the condensate, and radon daughters that may be deposited on any of the internal surfaces of the process system.

The building heating and ventilation system for the interior space of the RCS Building is a once-through system. The heating and ventilation system is comprised of separate supply and exhaust systems. The ducted supply air system draws outside air into the building by the RCS Building supply fan (FAN-77-003). The outside air enters through a filter (FLT-77-001) that reduces the amount of particulate loading in the intake system. An electric duct heater (HTR-77-012) heats the supply air when the outside temperature falls below design conditions. The carbon bed areas are not heated and have a different supply system than the air handling section of the building. Air supplied to the carbon bed rooms is being conditioned to maintain approximately 60 °F in the rooms at all times when required by the outdoor temperatures. At all other times, supplied air to the rooms will be at ambient temperatures.

Redundant centrifugal Building Ventilation Exhaust Fans (FAN-77-001A and FAN-77-001B) ventilate the interior space of the RCS Building. The fans and ducting system maintain the RCS Building at a negative pressure. The RCS Building ducting system is manually balanced. The direction of airflow is from areas of low potential contamination to areas of higher potential contamination. The prevailing pressure of the carbon bed area and the air conditioning area is monitored. The Building Ventilation Exhaust Fans maintain an induced draft (negative pressure) throughout the RCS Building and are located downstream of redundant HEPA filters (FLT-77-002A and FLT-77-002B). An emergency generator in conjunction with the redundant fans, chillers, carbon beds, HEPA filters, and PLCs provide the 100% availability requirement.

A separate exhaust register is supplied to each carbon bed area to extract ventilation air in the event of a leak of radon into the carbon bed rooms. This air is transferred to the RCS for treatment via the carbon bed drying line. The redundant HEPA filters and fans for the RCS and for the RCS Building ventilation are mounted in a pre-engineered structure located over the air conditioning areas. The stack is also mounted on the concrete pad.

The sequence of operation for the RCS is divided into Phase 1, Phase 2A, Phase 2B, Phase 2C & Phase 3, which are outlined below.

- Phase 1 Silo 1 and Silo 2 Headspace Reduction,
- Phase 2A Silo 1 Retrieval, Silo 2 Headspace Reduction, TTA Ventilation,
- Phase 2B Silo 2 Retrieval, TTA Ventilation,
- Phase 2C TTA Ventilation, and
- Phase 3 TTA Ventilation, Future Waste Treatment.

4.2.1 Phase 1 - Radon Control in the Silo Headspaces

During Phase 1, the ventilation air is withdrawn from Silos 1 and 2 and transferred to the RCS for treatment. The treated ventilation air is returned to the silos for sweep ventilation purposes. The desired pressure conditions are maintained by using an automatically controlled fan and damper system. The RCS will operate in this scheme to maintain radon concentration in the silo headspaces at concentrations that will allow safe access for work activities in the silo area.

The design flowrate for the ducting system for the ventilation of Silos 1 and 2 is based upon exhausting up to 500 cfm from each silo for Phase 1 operations. T he design also includes the flexibility to discontinue flow from one silo for a short period of time to increase the amount of air exhausted from the other silo in service. This capability may be used during the time the size of the openings in the silos will be increased for introduction of mining equipment to be used in the later phases. Recirculation will not be employed during this scheme of operation and all air from active silo will be exhausted through the stack.

During Phase 1, the RCS suction lines from Silos 1 and 2 will be flexible hoses routed over the berm with a low-point condensate trap. A ventilation stream from each silo through an existing opening in silo risers is exhausted through dampers DMP-20-049 and DMP-20-053, respectively, into 6-inch flexible hoses that connect to an 8-inch main duct header located on the pipe rack running to the RCS Building. Upon entering the building, the air is treated through either process train A or B as described above. After the air is treated and leaves the fan, it flows to an 8-inch silos' supply duct header that connects to two 6-inch flexible hoses routed over the berm, which connect to the silos by dampers DMP-20-047 and DMP-20-051, respectively.

Modulating dampers, LVR-20-004 and LVR-20-001 on the respective suction lines from Silos 1 and 2 along with modulating dampers, LVR-20-003 and LVR-20-002 on the respective supply lines to Silos 1 and 2 serve to help maintain a negative pressure (vacuum) within each silo. These dampers are motor-operated devices and are operated in a master and slave arrangement. Dampers LVR-20-003 and LVR-20-002 are designated as the master devices and provide full authority to modulate the silo pressure. During periods of system flux or other transient episodes, the dampers (LVR-20-004 and LVR-20-001) offer additional control in the event the other dampers exhaust their full range of authority before the target pressure is attained. Entry of the supply air into the silos is achieved through an opening opposite the one through which the air exhausted. By using opposing openings for the inlet and outlet airflow, the flushing of the radon-laden air from the silos is maximized.

The silos are further protected from an out-of-parameter pressure condition by two methods. In the event that a positive pressure spike remains unmitigated before attaining the desired condition, the supply is terminated and the system briefly goes into return-only or exhaust mode to damp the spike. Subsequently, the supply is bled back online and the desired condition is restored. Additionally, vacuum relief devices PCV-SILO-20-001 and PCV-SILO-20-002 protect the silos by providing the final relief from under-pressurization.

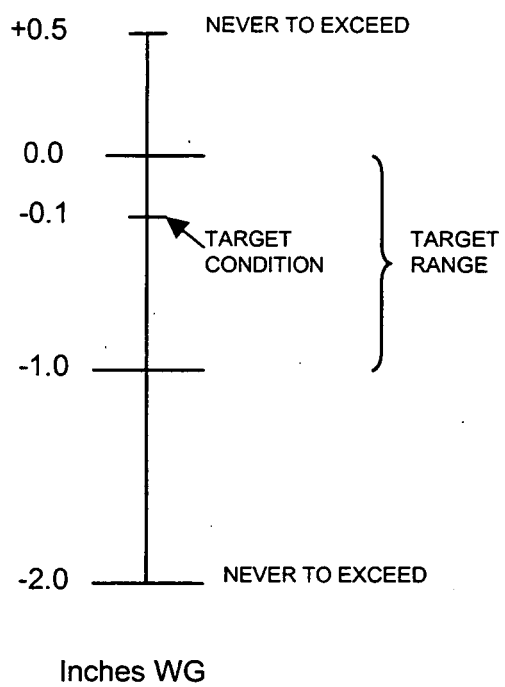
In an over-pressurization condition the device allows flow out of the silo. The effluent is routed back into the suction return line that has been put into a return-only mode as described previously. In an under-pressurization condition the device allows fresh air in and thus relieves the condition. Any such events are considered upset conditions and are not intended for

normal operation. Subsequent to such an event, the prevailing system conditions are analyzed to determine the causative issues so that operational adjustments can be identified and implemented.

If achievable, the normal operating target pressure is –0.1 inches WG. If due to the structural nature of the silos (large crack areas) the target pressure can be reset to atmospheric setpoint. The targeted range of operation is from 0.0 to –1.0 inches WG. The control system responds to maintain the target condition. Normal operations occur within the targeted range. Excursions beyond the targeted range are mitigated as discussed. The control devices, control strategy, and the pressure and vacuum relief mechanism ensure the "never-to-exceed" values of 0.5 and –2 inches (see figure).

To address the tightness of the silos that will be required for the subsequent phases of operation, a tyvek or heavy mil plastic cover will be used to cover the dome and sides of the silos. Use of this cover minimizes the amount of in-leakage or infiltration through cracks in the silos if required.

Once the Phase 1 operations have been successful in reducing the activity levels within the silos, construction will begin on the bridge and other systems to begin AWR operations. During this construction process, the pipe rack will be extended to its final termination point near the pivot point of the bridge. Three rigid duct spool pieces 1, 2, & 3 will be installed on the completed pipe rack that will run from the dampered, blinded-off connections in lines RCS-20006, RCS-20008, and 20069 to a final termination point on the bridge for Phase 2A operation.



For subsequent Phases 2A and 2B, the supply, suction, and pressure relief ducting for the silo being mined will be routed on the new bridge and connected to the RCS ducting on the pipe rack. RCS ducting on the pipe rack will be sloped to the RCS Building while ductwork on the bridge will slope to the silo being mined.

For Phase 2A operations, the bridge will be positioned over Silo 1. Both the RCS supply and suction connections on Silos 1 containing dampers DMP-20-046 and DMP-20-048 will be connected to rigid ducting, mounted on the bridge, by means of a short piece of flexible hose. The supply and suction ducting is routed on the new bridge and connected to the RCS ducting on the pipe rack by means of spool pieces 4 and 5. The pressure relief ducting from Silo 1 will also be connected to rigid ducting mounted on the bridge by means of a short piece of flexible ducting. The pressure relief ducting will be routed on the new bridge and connected to the RCS ducting on the pipe rack by means of spool piece 6.

4.2.2 Phase 2A, 2B - Radon Control during Material Transfer

When mining activities begin in Silo 1, the RCS moves from Phase 1 to Phase 2A. During this phase, recirculation air to Silo 1 is discontinued and the ventilation air is pulled into the silo through the three enclosures on the pivoting bridge that are used for waste retrieval from Silo 1. However, the capability to shutoff the enclosure louver intakes and place the silo in recirculation mode is still available if desired. Silo 2 continues to operate as before in Phase 1.

The design flowrate for the ducting system for the ventilation of Silos 1 and 2 is based upon exhausting up to 500 cfm from each silo for Phase 2A operations. The design also includes the flexibility to discontinue flow from one silo for a short period of time to increase the amount of air exhausted from the other silo in service.

Besides airflow from Silos 1 and 2, two of the TTA tanks will be in operation during Phase 2A. In Phase 2A, the TTA is tied into the RCS. The flow to the various major TTA components is controlled individually at each component. Air is drawn into the TTA through a single manifold and distributed to the waste transfer tanks by modulating dampers. The filter and filtrate storage tanks are vented to the RCS and a damper will open to relieve pressure. These tanks are equipped with vacuum control valves to let air into tanks when a vacuum setpoint is reached. During Phase 2A, only two of the four waste storage tanks are in service (TNK-12-001A and TNK-12-001B). After Phase 2A, the flow to those tanks can be reduced but not eliminated.

The design flowrate for the ducting system for the ventilation of TTA tanks is based upon exhausting up to 250 cfm from each TTA tank (TNK-12-001A and TNK-12-001B) for Phase 2A operations. Flow to and from these two tanks is controlled in the same manner as was outlined in the earlier section for the silos.

Before mining starts in Silo 1, the connections of the rigid ductwork on the bridge to the silo and to the duct header on the piperack must be verified. To begin Phase 2A operations, flow must be established through the ductwork on the bridge. The dampers associated with Phase 2A operation will be opened, DMP-20-046, DMP-20-048, DMP-20-054, DMP-20-081, and DMP-20-083. The dampers associated with Phase 1 operation will be closed, DMP-20-047, DMP-20-049, DMP-20-080, DMP-20-082, and DMP-20-084. Once flow is established through the ductwork on the bridge, the flexible hoses associated with Phase 1 operations for Silo 1 can be disconnected and removed. A blind flange shall be installed over the opening associated with the hose removal to provide additional sealing.

At the start of Phase 2A, the damper in the supply air duct to Silo 1 (the first silo to be emptied), LVR-20-003, begins closing upon opening of the automatic dampers on the enclosures. Inlet air for Silo 1 is provided directly through the three enclosures used in this phase for:

- Sluicing,
- Slurry transfer, and
- EMMA™ operations.

Each enclosure is served by a secondary containment that is attached to the opening using a seal arrangement that avoids placing any load on the silo dome. The moveable bridge that is positioned first over Silo 1, and subsequently over Silo 2, structurally supports the enclosures.

Each of the three enclosures has an air inlet equipped with a roughing filter, HEPA filter, automatic damper, and flow meter. Access to the enclosures is through air-locked doors that limit additional flow during entry and exit. Flexible seals are used to minimize the free space around equipment passing through the enclosure opening into the silo below.

After mining and decontamination activities are complete and before the application of the fixative to the inside surfaces of the silo, ventilation of Silo 1 will be discontinued. The dampers that were opened for initiation of mining activities listed earlier are now closed. Spool pieces 4, 5, and 6 are removed and the bridge is repositioned over Silo 2. Once in position the spool pieces are reconnected to their original connections. The ventilation strategy of Silo 2 during retrieval activities is identical to that of Silo 1. During Phase 2B, the increase in the availability of ventilation air, caused by stopping flow to Silo 1 increases the ability of the RCS to better control radon from other sources.

When mining activities begin in Silo 2, the RCS moves from Phase 2A to Phase 2B. During this phase, recirculation air to Silo 2 is discontinued and the ventilation air is pulled into the silo through the three enclosures on the pivoting bridge that are used for waste retrieval from Silo 2. However, the capability to shutoff the enclosure louver intakes and place the silo in recirculation mode is still available if desired.

The design flowrate for the ducting system for the ventilation of Silo 2 is based upon exhausting up to 500 cfm from each silo for Phase 2B operations. Besides airflow from Silo 2, two additional TTA tanks will be in operation during Phase 2B. The flow to the various major TTA components is controlled individually at each component. Air is drawn into the TTA through a single manifold and distributed to the waste transfer tanks by modulating dampers. The filter and filtrate storage tanks are vented to the RCS and will open to relieve pressure. These tanks are equipped with vacuum control valves to let air into tanks when vacuum setpoint is reached. During Phase 2A, only two of the four waste storage tanks are in service (TNK-12-001A and TNK-12-001B). During Phase 2B, the flow to those tanks can be reduced but not eliminated.

The design flowrate for the ducting system for the ventilation of TTA tanks is based upon exhausting up to 250 cfm from each TTA tank (TNK-12-002A and TNK-12-002B) for Phase 2B operations. Flow to and from these two tanks is controlled in the same manner as was outlined in the earlier section for the silos.

Before mining starts in Silo 2, the connections of the rigid ductwork on the bridge to the silo and to the duct header on the piperack must be verified. In Phase 2B, the dampers associated with Silo 1 control shall be used to control pressures in Silo 2 to minimize the number of specialized spool pieces required for movement of the bridge. To begin Phase 2B operations, flow must be established through the ductwork on the bridge. The dampers associated with Phase 2B operation will be reopened, DMP-20-046, DMP-20-048, DMP-20-054, DMP-20-081, and DMP-20-083. The dampers associated with Phase 2A operation will be closed, DMP-20-050, DMP-20-052, and DMP-20-058. Once flow is established through the ductwork on the bridge, the flexible hoses associated with Phase 1 operations for Silo 2 can be disconnected and removed. A blind flange shall be installed over the opening associated with the hose removal to provide additional sealing.

During material retrieval activities of Silo 2, the active waste storage tanks are TNK-12-002A and TNK-12-002B while TNK-12-001A and TNK-12-001B are ventilated at a lower rate. The

majority of the TTA flow is committed to tanks TNK-12-002A and TNK-12-002B. After mining and decontamination activities are complete and before the application of the fixative to the inside surfaces of the silo, ventilation of Silo 2 will be discontinued. The dampers that were opened for initiation of mining activities listed earlier are now closed. And after completion of Phase 2B, decant sump waste retrieval begins. This method for this activity is currently under development. Because of the transient nature of this operation, steady-state material balances were not required but RCS ventilation is balanced accordingly.

4.2.3 Phase 2C - Radon Control during Interim Storage

When mining activities are completed, the RCS moves from Phase 2B to Phase 2C. At the conclusion of the material retrieval campaigns the RCS ventilates various TTA components as required. Limited airflow can be maintained through TTA components during this phase. The system has the flexibility to recycle treated air back through the TTA manifold, or exhaust it through the stack. During the interim waste storage period, the waste storage tanks each have approximately 2 feet of water on top for shielding that reduces the radon release to the headspace.

The design flowrate for the ducting system for the ventilation of TTA tanks (TNK-12-001A and TNK-12-001B, TNK-12-002A and TNK-12-002B) is based upon exhausting up to 125 cfm from each silo for Phase 2C operations. Flow to and from these tanks is controlled in the same manner as was outlined in the earlier section for the silos.

4.2.4 Phase 3 - Radon Control during Future Material Treatment

During Phase 3, the RCS accommodates a design airflow rate of up to 500 cfm from the Future Full-Scale Remediation Facility in addition to the design airflow rate of up to 500 cfm from the TTA tanks. Dampers would again control the balance between the two inputs. If desired, the system can be operated in the recycle mode so that air from the TTA would pass through the carbon beds and return to the TTA, in much the same way the air is to be recycled through the silos during Phase 1. Airflow through TTA waste storage tanks would be discontinued after transfer of contents from that tank to the Future Full-Scale Remediation Facility is complete.

4.3 Decant Sump Waste Retrieval System

The DWRS will retrieve the waste from the Decant Sump located just west of and between the silos. The Decant Sump is a carbon steel, 18-foot long, 9-foot diameter cylindrical tank with dished ends. The tank is buried horizontally with a 20-inch opening centered at the top of the tank. A 30-inch corrugated manway centered over the 20-inch opening extends approximately 33 feet to the ground surface.

4.3.1 Deployment Strategy

Before silo recovery is initiated, a submersible pump and level indicator will be lowered into the Decant Sump Tank through the 20-inch opening. The pump and level indicator will remain in the tank throughout the Silo 1 and 2 retrieval campaigns. If the level rises in the tank during SWRS operations, then a tanker truck will be mobilized and the liquid will be pumped from the Decant Sump into the tanker truck. The pumping system will have the capability to remove

liquid from the tank at the rate of 40 gpm and will keep the liquid-level below 70% of the tank capacity.

The berm soil above the Decant Sump will be excavated during SWRS operations from an elevation of 603 feet to 586 feet, leaving approximately 16½ feet of ground cover above the Decant Sump. A concrete pad surrounded by a curb will be poured around the riser to support the retrieval equipment and contain any possible leaks. The retrieval method will be similar to the bulk retrieval method used in the SWRS with the exception that, because of the small amount of waste and small size of any expected debris, a mechanical arm will not be deployed.

A flange-mounted sluicer will inject filtered water at a rate of 20 gpm at 1,000 psi into the Decant Sump to create slurry. A vacuum truck will retrieve the slurry from the Decant Sump at a rate of approximately 80 gpm. After the vacuum truck is filled, its contents will be emptied into the TTA Storage Tanks. The headspace pressure of the Decant Sump will be maintained at a negative pressure using the RCS during normal operations. The exhaust from the vacuum truck vacuum pump will also be attached to the RCS to prevent uncontrolled releases of radon during the retrieval process.

During the sluicing operation, a camera and light will be mounted in the tank to ensure the system is operating as designed. If debris is located in the Decant Sump, manually operated remote telescoping gripping tools will then be used to remove it. The system will be operated locally.

4.3.2 Component Descriptions

The DWRS main system components are as follows:

- Flange-Mounted Sluicer,
- Vacuum Truck,
- Camera System, and
- Submersible Pump.

The flange-mounted sluicer consists of a blind flange, which has been modified to accept an electric tank-washing head, a 3-inch nozzle for RCS ventilation, a 3-inch nozzle for slurry extraction, a mast for supporting camera and lighting equipment, and level indicator. The blind flange will also be equipped with dowel pins for locating the flange on the existing 20-inch decant sump nozzle and eyebolts for hoisting assembly in and out of the 30-inch corrugated manway. The electric tank-washing head will spray two streams 180° apart and rotate about two axes simultaneously. This will allow mining of the K-65 residue and rinsing of the entire tank surface at the same time. The tank-washing head will receive water from the High-Pressure Pump Skid that has been reduced to 20 gpm and 1,000 psi.

The vacuum truck for pumping the slurry out of the Decant Sump will be supplied by Fluor Fernald. After the tank on the truck is full, its contents will be pumped into the TTA Storage Tanks and flushed with clean water, which will also be pumped into the TTA Storage Tanks. The submersible pump used during the SWRS operations will be the existing pump used on site for removal of free liquids in the Decant Sump Tank.

The camera and lights will be the same camera and lighting mounted in the dome of Silo 4 during FSM. The pan and tilt unit will also be used to allow the camera and lighting to view the entire inner surface of the decant sump.

4.4 TTA System

The TTA System is provided to store residues received from Silos 1 and 2. The TTA consists of a building that houses the Transfer Storage Tanks, a portable Sampling Module, a water makeup system, a water elimination system, and a piping network for receiving and transfer of residues from the silos to the Future Full-Scale Remediation Facility.

The TTA communicates directly with the following systems:

- Silo Waste Retrieval System,
- Decant Sump Waste Retrieval System,
- TTA Waste Retrieval System,
- Full Scale Mock-Up System, and
- Radon Control System.

The TTA is comprised of the following major features:

- Transfer Storage Tanks,
- Transfer Storage Tanks Enclosure,
- Equipment Deck,
- Equipment Deck Enclosure,
- Portable Sampling Module,
- Transfer Piping,
- Diverter Valves,
- Diverter Valve Containment Areas,
- Ultra-Filtration Equipment (including the Filter Process Tank),
- Filtrate Storage Tank,
- Filtrate Transfer Pumps,
- High-Pressure Decon Pump,
- Decant Pumps,
- Decant Pump Enclosures,
- Sluicers,
- Sluicer Enclosures,
- Slurry Pumps,
- Slurry Pump Enclosures,
- Makeup Water Storage Tank, and
- Makeup Water Transfer Pump.

The TTA is used in support of four different retrieval operations: FSMS, SWRS, DWRS, and TWRS. The functional description of the TTA in support of each operation is provided in the following paragraphs.

4.4.1 Full-Scale Mock-Up System

Transfer Storage Tanks TNK-12-001A and TNK-12-001B are used to supply sluice water and receive surrogate material from Silo 4 in support of the FSMS to demonstrate the SWRS concept. The same tanks are also used to transfer the surrogate material from Tank 1A to demonstrate the TWRS concept.

For FSMS demonstration of the SWRS operation, Tank 1B is used for the sluicing water and Tank 1A receives the surrogate material from Silo 4. This operation is accomplished by first adding process water for sluicing to Tank 1B.

> **Note:** Following tank construction and tank leak testing, approximately 750,000 gallons of water will remain distributed among the four Transfer Storage Tanks. The tank contractor will have left approximately 187,500 gallons in each tank. Approximately 125,000 gallons of the water in Tank 1A can be transferred to Tank 1B utilizing the Decant Pump, or the required water for Surrogate sluicing can be provided from Makeup Water Tank TNK-51-001.

Decant Pumps are installed on Tanks 1A and 1B in the mode to demonstrate SWRS. Pump control is accomplished with the PLC and level transmitters in each tank. Valve alignments are selected by the PLC to set up the sluice water flow path from Tank 1B to the Sluicer located in Silo 4, and from the Slurry Pump located in Silo 4 to Tank 1A in support of surrogate Silo 4 bulk waste retrieval.

Silo 4 surrogate heel retrieval is accomplished in the CATS mode. The CATS mode requires high-pressure water that is provided by the high-pressure pumps located near the Silo 4 bridge. The supply to the Silo 4 high-pressure pumps is from Makeup Water Tank TNK-51-001. The slurry received from Silo 4 in the CATS mode is transferred to Tank 1A. Sluice water for the Silo 4 sluicer is available from Tank 1B if needed to support the CATS mode.

For demonstration of the FSMS TWRS mode of operation, Tank 1B is used for the sluicing water (during the actual TWRS, sluice water must be supplied from the Future Remediation Facility [NIS]) and the surrogate is retrieved from Tank 1A and pumped to the surrogate dewatering area. The Decant Pump installed in Tank 1B remains in place from the FSMS SWRS, and Tank 1A is equipped with two Sluicers and the TTA Slurry Pump.

The TTA Slurry Pump is not equipped with a Coriolis effect mass flow meter, unlike the Slurry Pumps located at the silos. Therefore, during FSMS TWRS mode, the Coriolis flow meter in the main sluice water header must be switched to the main slurry header. Interchangeable flanged spool pieces are provided in the main sluice water header and the main slurry header and are designed to accept the Coriolis flow meter. This is necessary to measure the discharge flow and control the sluice water bypass valve to maintain the slurry density.

Pump control for FSMS TWRS is accomplished with the PLC and level transmitters in each tank. Valve alignments are selected by the PLC to set up the sluice water flow path from Tank 1B to the Sluicers located in Tank 1A, and from the Slurry Pump located in Tank 1A to surrogate dewatering area. The TWRS does not require use the CATS equipment to empty a Transfer Storage Tank.

4.4.2 Silo Waste Retrieval System

The received slurry waste will undergo a settle and decant operation to concentrate the waste slurry for interim storage in tanks to await the construction of the Future Remediation Facility (NIS). Transfer Storage Tanks TNK-12-001A and TNK-12-001B are used to supply sluice y water and receive material from Silo 1. Transfer Storage Tanks TNK-12-002A and TNK-12-002B are used to supply sluice water and receive material from Silo 2. Silo 1 residues are removed before Silo 2 residues are removed. After Silo 1 has been emptied, the level instrumentation and pumps in Tanks 1A and 1B are moved to Tanks 2A and 2B. Also, excess supernatant (excess supernatant is that remaining above 90% tank capacity) in Tanks 1A and 1B can be pumped to Tanks 2A and 2B instead of filtering the water and transferring it to the AWWT for elimination. The process begins for Silo 2 and is operated in the same manner as with Silo 1.

The following description is for TTA-Silo 1 operation; TTA-Silo 2 operation is similar. For retrieval operation, Decant Pumps are installed in Tanks 1A and 1B. Pump control is accomplished with the PLC and level transmitters in each tank. Valve alignments are selected by the PLC to set up the sluice water flow path from the tank being used for decant, either Tank 1A or 1B, to the Sluicer located in Silo 1; and from the Slurry Pump located in Silo 1 to the slurry feed tank, either Tank 1A or 1B.

Prior to the sluicing operation, start-up water will be added as required to the two tanks, Tanks 1A and 1B in this case. This initial volume of water is roughly equal to the total amount of water to be added for transferring the silo residues to the TTA. The volume required for Silo 1 is approximately 535,000 gallons, and the volume required for Silo 2 is approximately 488,000 gallons. These quantities account for the in-situ water in the silos. Of the 535,000 gallons required for the Silo 1 campaign, 250,000 gallons of water will initially be made available in each tank, with the remainder to be added as needed. This amount of water provides a level of approximately 10 feet in each of the 750,000-gallon tanks. For the Silo 2 campaign, 225,000 gallons is made available in Tanks 2A and 2B. This amount of water and supernatant from the Silo 1 tanks provides a level of approximately 9 feet in each of the 750,000-gallon tanks.

At the beginning of the bulk retrieval mode, bentonite will be the primary solid constituent in the slurry. The 15 WT% bentonite slurry will be deposited in Tank 1A where settling will be enhanced due to the presence of the start-up water. As discussed previously in the "Bulk Sluicing and Retrieval" section, the mining strategy is to expose the K-65 layer below the slurry pump and create a slurry pool in the first stages of mining. To accomplish this mining requires that a canyon be created between the sluicer and the slurry pump. This canyon will allow the operator to favor the K-65 material, and allow the bentonite to wash into the mix, thus selectively mining the bentonite.

The system is designed to allow the slurry feed tank and sluice water tank to change roles periodically. For example, sluice water may be supplied from Tank 1B during one period, while slurry is being pumped into Tank 1A. The received slurry in Tank 1A is allowed to settle, and during the next operating period sluice water is the supernate from Tank 1A, and the slurry is pumped to Tank 1B. This tank-switching sequence is performed during Bulk Retrieval and CATS modes, as required, typically once daily.

At the beginning of each operating period, tank levels are measured as well as the residue levels to determine retrieval progress from the previous operating period. At the conclusion of each operating day, the slurry transfer piping is flushed with sluice water for a period of 10 minutes. This operation is accomplished by diverting the sluice feed flow from the Sluicer to the slurry line.

Silo 1 heel retrieval is accomplished in the CATS mode. The CATS mode requires high-pressure water that is provided by the high-pressure pumps located near the Silos 1 & 2 bridge. The supply to the high-pressure pumps is from the TTA Filtrate Transfer Pumps that transfer water from the TTA Filtrate Storage Tank. Level in the TTA Filtrate Storage Tank is maintained by batch operation of the Ultra-Filtration (UF) Unit. Makeup water for the TTA Filtrate Storage Tank is also available from the Makeup Water Tank and from the RCS Condensate Holdup Tanks. The slurry received from Silo 1 in the CATS mode is transferred to either Tank 1A or 1B. Sluice water for the Silo 1 Sluicer is available from either Tank 1A or 1B, as required to support the CATS mode.

4.4.3 Decant Sump Waste Retrieval System

The TTA piping systems will not be used to receive the residues from the DWRS. The residues will be deposited directly into either Tank 2A or 2B through one of the spare tank risers. For a complete description of this process, refer to the Decant Sump Waste Retrieval System Description.

4.4.4 Transfer from Tank Waste Retrieval System

During the TWRS, the K-65/BentoGrout™ is slurried from the storage tanks to the Future Full-Scale Remediation Facility (NIS) in the same way it was removed from the silos except two sluicing nozzles are deployed in the storage tank being emptied, and the CATS system and EMMA™ are not required. The storage tank bottoms are sloped to a center sump to facilitate heel removal. The Slurry Pump is deployed in the center tank nozzle. When one tank is completely emptied, instrumentation, cameras, pumps, and sluicers are moved to the next tank. The operation is repeated until all four tanks are emptied.

Sluice water for TWRS is provided from the Future Full-Scale Remediation Facility (NIS) through a flanged connection located in the sluice water line. The flanged connection is made available by relocating the Coriolis effect mass flow meter from the sluice water line and installing it in the primary slurry line. The slurry discharge connection to the Future Full-Scale Remediation Facility (NIS) then is downstream of the Coriolis flow meter.

The TTA Slurry Pump is not equipped with a Coriolis effect mass flow meter, unlike the Slurry Pumps located at the silos. Therefore during TWRS, the Coriolis flow meter in the main sluice water header must be switched to the main slurry header. This meter is necessary to measure the discharge flow and control the sluice water bypass valve to maintain the slurry density.

4.4.5 Transfer Storage Tanks

Four Transfer Storage Tanks are provided for storage of wastes from Silos 1 and 2, and from the silos Decant Sump. The K-65 material and BentoGrout™ from Silo 1 are stored in two of the four tanks, and the K-65 material and BentoGrout™ from Silo 2 is stored in the other two

tanks. The residue in the Decant Sump is transferred to the storage tanks assigned for receipt of wastes from Silo 2.

The carbon steel Transfer Storage Tanks each have a capacity of 750,000 gallons and are constructed in accordance with American Petroleum Institute (API)-650. The tank volume was selected to allow for a maximum storage level of 90% of total capacity, although the tanks are designed for filling to their maximum capacity. The tanks are 66 feet in diameter, have a straight side dimension of 30 feet, and are provided with 1/4-inch corrosion allowance. The exterior surfaces of the tanks are painted. The tank roofs are dome shaped and are supported by rafters to minimize the overall height to 33-feet, 6-inches (excluding nozzle risers) from the top of their concrete foundations. The tank bottoms are sloped to a center sump to facilitate residue removal during TWRS.

The two tanks designated for storage of Silo 1 wastes (TNK-12-001A and TNK-12-001B) are connected at their overflow nozzles by a 6-inch diameter pipe. The tanks for storage of Silo 2 wastes (TNK-12-002A and TNK-12-002B) are likewise connected. This overflow arrangement together with the use of two level measurement devices in each tank minimizes the potential of exceeding the capacity of any one tank. Tank ventilation is provided by the RCS. Pressure and vacuum relief devices limit the tank headspace pressure to a range of -2.0 inches to +0.5 inches WG.

Tank nozzles, except for the overflow, are located on the tank roof. The roof nozzles are parallel to the tanks vertical axes and extend through sleeves in the equipment deck. Flexible boots are attached to the nozzles and the floor of the equipment deck to isolate the tank enclosure. These boots provide an air seal and allow independent movement between the deck and the nozzles, thereby virtually eliminating reaction forces and moments to the tank.

Each tank is provided with the following roof nozzles:

- One 48-inch diameter located in the center for the Decant Pump or the Slurry Pump;
- Two 20-inch diameter located 90° apart for the Sluicer Modules;
- One 20-inch diameter for the RCS inlet;
- Six 12-inch diameter for the level switch, pressure differential transmitter, camera, and three are spares.
- Three 6-inch diameter for level, slurry inlet, and RCS outlet;
- One 6-inch diameter overflow located in the shell; and
- One 4-inch diameter for relief/vent.

Tank corrosion considerations include adding 1/4-inch additional thickness above that required for stress to the steel tanks, and painting the tank exterior steel surfaces. The use of an interior coating is being evaluated. An active cathodic protection system is not required for the tanks. The tanks are housed completely within the concrete and steel enclosure, and are grounded to the TTA grounding grid. The grounding grid maintains the building steel, including the reinforcing steel, and components at the same electrical potential.

4.4.6 Transfer Storage Tanks Enclosure

The Transfer Storage Tanks Enclosure is a concrete structure that provides secondary containment of stored wastes and radiation shielding. This structure is 152-feet long, 152-feet

wide, and approximately 40-feet tall with 24-inch thick walls for shielding. Secondary containment is provided by sealing the concrete floor and the walls to a level of eight feet above the floor. This containment is equivalent to the volume that could be occupied by residue from one 750,000-gallon tank.

The floor is sloped to a centrally located sump to facilitate removal of spills. A tank foundation sump is also provided under each tank to collect any leakage that may occur through or around the tank bottoms. The four tank foundation sumps drain by gravity to the main enclosure sump by piping embedded in the tank foundation pads. Access to the sump pump is through an opening in the diverter valve containment area located on the equipment deck above the main sump. The main sump is equipped with level instruments for spill detection. The sump pump discharge piping is routed to the slurry distribution manifold within the same diverter valve containment area for transfer to any of the four tanks. Each tank has an exposed bottom sump drain line that empties into the central sump trench thus allowing the operator to identify that tank is leaking by the camera system that can see all four sump lines. There is no ventilation provided in the Transfer Storage Tank Enclosure because this area does not require entry by personnel. For a detailed description of tank repairs, see *Contingency Plan and Emergency Response*, Document No. 624-P621-09, for the AWR Project.

4.4.7 Equipment Deck

The equipment deck covers the storage tanks. The equipment deck is supported by a steel column and beam system designed to carry floor and equipment loads. The support steel is primed and painted. The floor is 9-inch thick concrete. The equipment deck provides radiation shielding from the stored residues during maintenance activities.

Equipment handling is a key element in the design of the TTA. A Loading Platform located on the south side of the TTA is provided for installation and removal of equipment supporting the SWRS, FSMS, and TWRS. The Sluicer modules, Slurry Pump modules and Decant Pump modules are installed in the TTA by first being lifted by portable crane from a ground transport vehicle to the Loading Platform where the modules are placed on and secured to air bearings. Access to the Equipment Deck is provided through a 16-feet wide, 24-feet-high roll-up door. Air hoses are connected to the air bearings and to the compressed air header located inside the Equipment Deck Enclosure. The air bearings allow the heavy loads to be easily moved on a near frictionless cushion of air. Workers manually guide each module to the desired location for interface with the Transfer Storage Tank riser nozzle.

The Loading Platform is also fitted with a monorail type hoist for use when tools and equipment parts are to be taken in, or removed from, the TTA. Two staircases provide access to the Equipment Deck. One staircase is located on the north end of the east side of the TTA, and the other is located adjacent to the Loading Platform on the south side of the TTA.

4.4.8 Equipment Deck Enclosure

The Equipment Deck Enclosure is a pre-engineered metal building constructed over the equipment deck to protect the TTA equipment and manage precipitation. Rain and melting snow runoff directly to the storm drainage system. The deck enclosure is insulated and provided with heaters to maintain a target temperature of 40 °F during cold months. Louvers and vents provide natural ventilation.

The equipment deck area is typically occupied by personnel only when lines have been flushed, or when the transfer systems have been shutdown for maintenance. The deck enclosure is also provided with doors, lights, gutters, and downspouts. A compressed air header is routed around the perimeter of the enclosure with several drops provided to support maintenance activities.

4.4.9 Transfer Piping

The TTA System piping material is carbon steel. Sluice water lines and slurry transfer piping are double-walled, except within the diverter valve containment areas where it is single-walled. The diverter valve containment areas provide secondary containment. Piping insulation and heat trace is not required because the Equipment Deck Enclosure is heated.

4.4.10 Diverter Valves

The TTA is equipped with motor-operated diverter valves for selection of slurry and sluice water flow paths. A diverter valve is a three-ported double waterway valve. Use of diverter valves eliminates the concern for dead-legs in the piping system that may plug with residue. Diverter valves are also compact and can easily be arranged inside containment areas or enclosures for maintenance and leak detection.

4.4.11 Diverter Valve Enclosures

There are two containment areas located on the TTA Equipment Deck. Within these areas, piping is singly contained and enables use of flanged joints for valves and equipment. The flanges within these areas are fitted with flange guards to prevent spray from a leaking joint. The areas have a sloped bottom and sump equipped with level instrumentation to detect leaks and a sump pump. The sump pump discharge lines are connected to the sluice water header, for return to a TTA Transfer Tank.

One containment area is centrally located on the TTA Equipment Deck. This area contains the diverter valves for connecting the primary and secondary slurry headers to the four storage tanks, as well as the sluice water distribution header. Connection for the building sump pump discharge is located within this area. This area also provides access to the building sump pump. The other containment area is located on the north side of the TTA Equipment Deck. This area contains the UF Unit, the Filter Process Tank, the Filtrate Storage Tank, the Coriolis mass flow meter, the Filtrate Transfer Pumps, the High-Pressure Decontamination Pump, and the make-up water connection.

4.4.12 Ultra-Filtration Equipment

The UF system is used to support water treatment from the TTA. Here suspended solids are removed from the effluent stream in a tubular membrane filtration unit. The unit is sized to process 20 gpm and is located in a contained area on the TTA Equipment Deck. The UF system includes a 300-gpm process pump that circulates water from the Filter Process Tank, through the filter producing 20 gpm of filtrate, and returning 280 gpm back to the Filter Process Tank. Filtrate discharged from the UF system is passed to the Filtrate Storage Tank where it is used to support other processes, or discharged to the FEMP AWWT facility. Solids separated

in the UF system are returned to the Filtrate Process Tank and eventually to the Transfer Storage Tanks by the slurry distribution header.

4.4.13 Filtrate Storage Tank

One 7,500-gallon storage tank (TNK-12-004) is provided for storage of filtrate effluent from the UF system. This tank has sufficient capacity for a full day's production of the UF system at maximum capacity. Tank ventilation is provided by the RCS. Pressure and vacuum relief devices limit the tank headspace pressure to a range of -2.0 in. to +0.5 inch WG.

The tank is constructed in accordance with API-650. It has a flat bottom supported on a concrete foundation, and the roof is dome shaped. The tank is equipped with level instruments to shutdown the UF system on high tank level. Corrosion considerations include painting external tank steel surfaces and providing a corrosion allowance of 1/16 inches. Additionally, the interior of this tank has a Plasite coating with a Dry Film Thickness of 30 mils.

4.4.14 Filter Process Tank

The Filter Process Tank (TNK-12-003) is used to store 7,500 gallons of sluice water that is transferred from the Transfer Storage Tanks at the beginning of each operating period (day) to be used by the UF system to produce filtrate. As filtrate is produced at a nominal 20 gpm and transferred to the Filtrate Storage Tank, a bleed stream from the sluice water header maintains the level of the Filter Process Tank. At the conclusion of the operating period, the thickened sluice water (approximately 2 WT%) is returned to the Transfer Storage Tanks. The Filter Process Tank is equipped with a mixer that is used for solids suspension before transferring the thickened sluice water back to the Transfer Storage Tanks.

Tank ventilation is provided by the RCS. Pressure and vacuum relief devices limit the tank headspace pressure to a range of -2.0 inches to +0.5 inches WG. The tank is constructed in accordance with API-650. The tank has a flat bottom supported on a concrete foundation, and the roof is dome shaped. The tank is equipped with level instruments to shutdown the transfer pumps on level. Corrosion considerations include painting external tank steel surfaces and providing a corrosion allowance of 1/16 inches. (The use of interior tank coatings is being evaluated.)

4.4.15 Filtrate Transfer

Filtrate is transferred from the Filtrate Storage Tanks by centrifugal pumps located on the TTA Equipment Deck. The Transfer Pumps can either transfer the filtrate to the AWWT facility or circulate the filtrate out to the silos and back as a feed stream for the high-pressure systems. The PLC automatically stops the pumps on low tank level.

4.4.16 Decant Pumps

The Decant Pump, used to power the Sluicers, is deployed from its enclosure located over the center nozzle of a Transfer Storage Tank. The pump is mounted on a floating platform consisting of two rigid pontoons connected by a folding frame. The spring-loaded frame folds under its weight when lifted vertically. This folded configuration allows the deployment of the platform through a 48-inch diameter nozzle. After the platform is placed in the tank, the pump,

motor and base are lowered onto the platform and aligned by guide-plates and secured over taper pins. Slack hose and cable is suspended in the tank with enough length to allow the pontoon platform to reach the bottom of the tank. As the tank is filled and the platform raises, lengths of cable and hose are disconnected and retracted from the riser.

The Decant Pump lowers into the Transfer Storage Tank using two hoists located on the ceiling of the Decant Pump Enclosure. Hoists are used only in manual control. The PLC does not control the hoists. Manual up and down buttons located on the control panel are used to control the hoists.

There are two independent Decant Pump systems. One decant pump is in Tank A and the other is in Tank B during SWRS operations. When SWRS operations are ready to begin on the other silo, the pumps move to the second set of A and B tanks in the TTA building. A sensor is mounted near the pump intake to determine liquid-level. If the liquid-level is low, then the sensor detects the low-level and turns the pump off.

The pump is a single-speed, self-priming, centrifugal pump operating at 3,500 rpm. The pump is sized to deliver 300 gpm to the Sluicer at 150 psi. Pump-wetted parts are carbon steel or ductile iron, except the shaft that is stainless steel. The decant pump motor is rated at 60 hp. The motor requires 480-V AC, three-phase power.

4.4.17 Decant Pump Enclosure

The Decant Pump Enclosure is built with a structural steel tubing frame, with steel sheet metal welded to the frame. It has one airtight access door, one equipment pass-through door, and sufficient gloveports and windows to allow equipment maintenance. The enclosure contains the equipment needed to allow the pump to function. Equipment includes two 1-ton hoists to install and remove the pump from the tanks, one hose reel to hold the pump discharge hose, one cable reel to hold the pump motor wiring, and two 3-inch, three-way ball valves and piping to direct the flow. The enclosure also contains a spray ring to decontaminate the pump assembly when it is removed from the tank. The circuit breaker box and terminal strip box for the electric components and motors is located on the outside wall of the enclosure.

The enclosure serves as secondary containment and drains to the storage tank. An air inlet damper is provided with HEPA filtration. The enclosure is connected to the RCS by connection to the Transfer Storage Tank to provide control of the enclosure atmosphere.

4.4.17 Sluicers

For a description of the Sluicers, see the SWRS design description in Section 4.1.2.1 of this document.

4.4.18 Sluicer Enclosures

For a description of the Sluicer Enclosures, see the SWRS design description in Section 4.1.2.2 of this document.

4.4.19 Slurry Pumps

For a description of the Slurry Pumps, see the SWRS design description in Section 4.1.2.3 of this document.

4.4.20 Slurry Pump Enclosures

For a description of the Slurry Pump Enclosures, see the SWRS design description in Section 4.1.2.4 of this document.

4.4.21 Makeup Water Storage Tank

The Makeup Water Storage Tank is a 10,000-gallon, atmospheric, steel water tank. The tank is designed and constructed in accordance with API-650 and is located on a flat concrete pad foundation outside the TTA, adjacent to the Electrical Building. Corrosion considerations include painting external tank steel surfaces and providing a corrosion allowance of 1/16-inch. The interior of this tank has a Plasite coating with a Dry Film Thickness of 30 mils.

4.4.22 Makeup Water Transfer Pump

Makeup water is provided to the TTA systems by a connection in the sluice water distribution header. The connection is in the north containment area on the TTA Equipment Deck. A centrifugal pump designed to deliver 200 gpm is located outside adjacent to the storage tank.

4.5 TTA Waste Retrieval System

The TWRS is designed to access, mobilize, and transfer residue stored in the TTA System. The TWRS is comprised of the TTA System and support features included within the Future Full-Scale Remediation Facility (NIS). Sluicers, Slurry Pumps and equipment used for the SWRS are also deployed for the TWRS.

The function of the TWRS is to provide the capability to retrieve and transfer the entire inventory of waste from the TTA Transfer Storage Tanks (TTA tanks) to the Future Full-Scale Remediation Facility for final treatment and disposal. The same equipment used for the SWRS will also be deployed by the TWRS with one major design enhancement. The TTA tanks will have two opposing sluicer assemblies per tank with a central slurry pump, thereby eliminating the need for heel removal. The equipment will be of the same design and fully interchangeable. Therefore, the sluicer assembly used in the silos will be the same as the sluicer assembly used in the TTA tanks. The central Slurry Pump is the same as that equipment used for the silos, except that the CATS portion of the equipment is not included. The two sluicer assemblies and the central slurry pump will permit a "swirl" movement of the waste within the tank as the waste is removed. This swirl will result in providing a more uniform plain of waste material and will also provide a continuous layer of water atop the waste for shielding purposes. By avoiding a fixed placement pump, the retractable slurry pump will avoid a central "well" within the waste and the possibility of exposed waste regions and results in a continuous layer of water being maintained during retrieval operations over the entire tank.

Equipment is provided for the transfer of stored residues from one TTA tank at a time. Diverter valves with flange connections are provided for connecting slurry and sluice water piping to and

from the Future Full-Scale Remediation Facility using the existing decant pumps. Sluice water for TWRS operations is supplied from the Future Full-Scale Remediation Facility using the same settle and decant approach. The TTA System provides piping and valves between the future remediation facility interface point and each of the four TTA tanks. The two Sluicer modules and the Slurry Pump module are connected to the storage tank being emptied. When one tank is completely emptied, instrumentation, cameras, pumps, and sluicers are moved to the next tank. The operation is repeated until the four tanks are emptied.

Personnel access is limited during retrieval operations. Cameras observe placement of each sluicer nozzle to permit remote operation. Controls are provided to limit individual exposures to less than 800 millirem per year. Operating controls for the TWRS are included in the AWR control room. These controls allow for the shutdown or startup of TWRS equipment. Local controls for the TWRS subsystems are provided on the TTA Equipment Deck.

Automated functions of the TWRS are controlled by PLC. These controllers process system events that require alarming. Local evacuation alarms are staged on the TTA Equipment Deck. The alarms can also be activated from the Vitrification Pilot Plant (VitPP) control room and the AWR Project control trailer. Alarms are recorded and annunciated locally, in the VitPP control room, and in the AWR Project control trailer.

The TWRS is comprised of the following major features:

- Transfer Storage Tanks,
- Transfer Piping,
- Diverter Valves,
- Sluicers,
- Sluicer Enclosure,
- Slurry Pumps, and
- Slurry Pump Enclosure.

4.5.1 Transfer Storage Tanks

For a description of the Transfer Storage Tanks, see the TTA System design description in Section 4.4.5 of this document.

4.5.2 Transfer Piping

For a description of the Transfer Piping, see the TTA System design description in Section 4.4.11 of this document.

4.5.3 Diverter Valves

For a description of the Diverter Valves, see the TTA System design description in Section 4.4.12 of this document.

4.5.4 Sluicers

For a description of the Sluicers, see the SWRS design description in Section 4.1.2.1 of this document.

4.5.5 Sluicer Enclosure

For a description of the Sluicer Enclosure, see the SWRS design description in Section 4.1.2.2 of this document.

4.5.6 Slurry Pumps

For a description of the Slurry Pumps, see the SWRS design description in Section 4.1.2.3 of this document.

4.5.7 Slurry Pump Enclosure

For a description of the Slurry Pump Enclosure, see the SWRS design description in Section 4.1.2.4 of this document.

4.6 Facilities Decontamination System

The FDS removes gross contamination from the silos, the decant sump tank, and contaminated process equipment as part of facility demobilization and closure. The FDS offers two categories of gross decontamination activities. First, the FDS provides gross decontamination of silos, decant sump tank and process equipment, as well as permanent facilities erected during the project, especially those left behind for management of the waste and radon effluent until the time that the waste is remediated. The second type of gross decontamination that the FDS provides is the processing of temporary tools, equipment, and facilities used on the AWR Project.

4.6.1 Silos Decontamination and Fixative Application

Gross decontamination of permanent facilities includes decontamination of the internal surfaces of the silos. The Fixative Spray System (FSS) is used after the internal surfaces of the silos are accessed and decontaminated to remove visible loose contamination, as verified by CCTV inspection. The FSS applies a fixative to the walls and floors of the silos after completion of waste and debris removal to prevent any radionuclides in the concrete surfaces from becoming airborne. The fixative is a water-based, paint-like liquid material that has properties that allows it to contain radioactive contamination under the fixative layer after it dries. More than one layer of fixative may be applied as necessary to achieve the necessary level of sealing of the silo walls.

The FSS consists of a pump, hose, nozzle, and small, positive-displacement pump. The fixative, which is liquid and pumpable, is delivered in 55-gallon drums and placed next to the pump. The pump delivers the fixative at approximately 100 psi at less than 5 gpm. A fixed length hose is connected to the outlet of the pump and leads up to the Silo-Arm Interface Enclosure (SAIE) where it is connected to a hose in EMMA™. The hose terminates at a nozzle

close to the end of the arm. The nozzle is similar to an industrial painting nozzle. The EMMA™ maneuvers the nozzle near the walls and floors to locally spray the fixative to the surfaces. The flexibility of the EMMA™ allows for fixative to be applied in a consistent and comprehensive manner over the entire surface area of the silo walls. Provisions are made to prevent the fixative material from being sprayed onto the cameras inside the silos that are used to observe the fixative application process.

4.6.2 Access/Decontamination/Packaging for Significant Structures and Components

Gross decontamination includes flushing and draining the lines used to transfer the waste slurry to the TTA, and gross decontamination of the interior surfaces of the silos and the decant tank. Material is removed from the interior surfaces of the silos to the visibly clean state before the application of the fixative as described above.

Gross decontamination will also include the cleaning of surfaces in the accessible areas of the RCS and the TTA. Areas that are high radiation areas (i.e., the Carbon Bed Rooms and the Tank Area of the TTA) are not included in this decontamination effort. However, the high radiation areas are not intended to be contamination areas. The decontaminated areas are cleaned of removable contamination, and the unremovable contamination is fixed in place.

Materials used in the performance of the gross decontamination process are water and wiping materials. Water is transferred to the TTA and processed along with water in the decant tank. Wiping materials are packaged for disposal as radioactive waste.

4.6.3 Decontamination/Demolition at Completion of FDS Operations

Facilities and equipment are surveyed, decontaminated, and presented to Fluor Fernald health physics technicians for release survey. This process is enhanced by minimizing the potential for contamination of the equipment or facilities through such practices as painting surfaces with strippable paint or wrapping them with plastic as allowed without affecting performance.. The location and use of each object is tracked to help justify an exemption from complete disassembly when it can be shown that the potential for contamination is exceedingly small. A plan is prepared for decontaminating and surveying each piece or type of equipment/facility as appropriate, considering the use of the equipment/facility. These plans are submitted to Fluor Fernald for review and concurrence before the performance of the decontamination and survey. After agreement is reached, Fluor Fernald performs the verification survey on decontaminated and surveyed items.

4.6.4 Decontamination/Packaging/Staging of Contaminated Materials

Wastes generated in the decontamination of temporary equipment and facilities consist primarily of wiping materials, water, and contaminated grit if abrasive blasting is needed to clear parts. These materials are packaged and disposed of as radioactive waste.

Decontamination of discrete objects and failed equipment will be performed in a portable, truck-mounted decontamination facility. This facility provides for cleaning of equipment as large as 18-feet by 30-feet, and collects the water and abrasive cleaning media used in the cleaning process. The survey of material for unrestricted release, which precedes making the material available to Fluor Fernald for verification survey, is done in an area within a facility reserved for

this function where background radiation levels are low enough to achieve the desired instrument sensitivity. This facility is located in the southwest section of the AWR Project site. An equivalent facility is provided for the Fluor Fernald verification.

4.7 Full-Scale Mock-Up System

The FSMS is designed to provide operator training and proof-of-principle testing of the following AWR Project systems: SWRS, TTA System, and TWRS. This testing includes the removal and transfer of K-65 silo surrogate material and debris. Also, this testing will be performed in a nonradioactive environment using Silo 4 and modified Silo 4 superstructure facilities. A process schematic of the FSMS and its sequence of operation are shown in Exhibit 4-1.

FSMS refers to the specific SSCs that are installed at the Silo 4 facility. FSM refers to the integrated overall mock-up system including the FSMS. The FSMS tie-ins to the waste retrieval system will be removed at the completion of the FSM ICAT/SOT. A portion of the FSMS will remain as a stand-alone system ensuring continued availability for training, system optimization and troubleshooting throughout the AWR Project operations phase.

The basis for the amount of surrogate required for the FSMS is equivalent to the amount of waste material to be removed from Silos 1 and 2 in one 8-hour shift. This amount corresponds to 44 gpm (21,120 gallons per eight-hour shift) or a total of 2,813 cubic feet of surrogate material. In addition, approximately 206 cubic feet of Bentogrout™ is required for the FSM. To more closely simulate the waste material depth in Silos 1 and 2, a tank will be located inside Silo 4 allowing for a surrogate material depth of 3.8 feet is used.

The tank footprint covers three manways into Silo 4. The tank is 8-feet wide and 6-feet high with a 48-feet, 3¾-inch long straight section starting 5 feet behind the sluicing nozzle manway and going toward the center of the tank. The overall length of the tank is 70 feet, ¾ inches. The tank expands on a 78° angle from the center of the central manway and extends to the Silo 4 wall. The expanded section allows slurry to collect and be transferred by the retrieval slurry pump. The wall of the inner tank that connects the angular section is curved to allow demonstration of the cleaning of silo walls and floor. Four-foot high, plywood splashguards are installed on top of the tank to contain the surrogate during sluicing.

INFORMATION ONLY

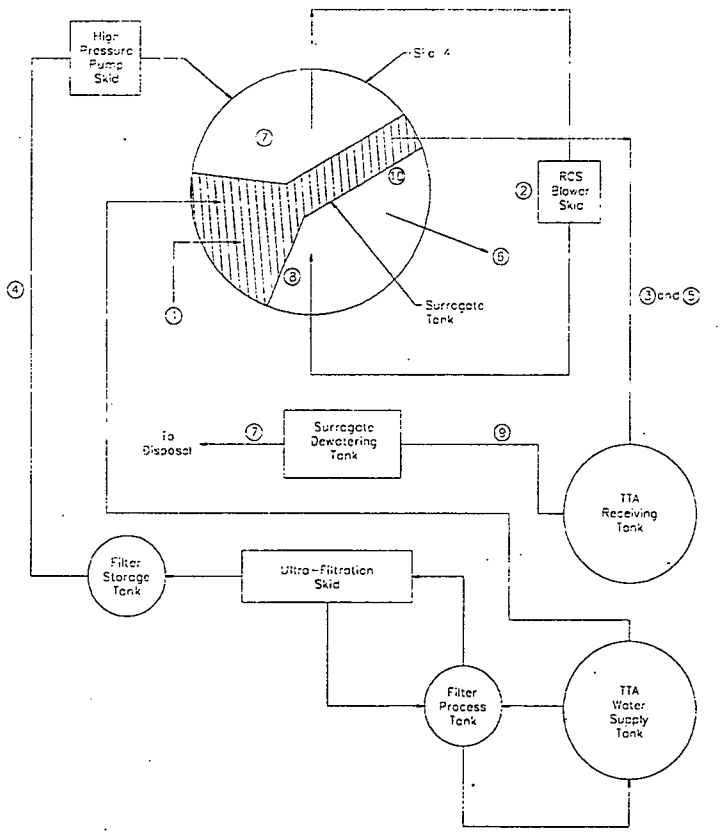


Exhibit 4-1. Full-Scale Mock-Up System

The FSMS is comprised of the following major features:

- FSMS Surrogate Tank,
- RCS Blower Skid,
- Equipment Deck,
- Equipment Deck Enclosure,
- Transfer Piping,
- Diverter Valves,
- Surrogate Settling Tank,
- Dewatering Pump and Duplex Filter,
- Sluicers,
- Sluicer Enclosure,
- Slurry Pump,
- Slurry Pump Enclosure,
- EMMA™,
- EMMA™ Enclosure,
- CATS,
- High-Pressure Pump Skid,
- SREE, and
- SDRS.

The FSMS communicates directly with the following systems:

- TTA Waste Retrieval System,
- TTA System, and
- UF System.

The FSMS is used to validate and optimize equipment integration for AWR Project system operations using the following process sequence (Note: The numbers correspond to numbers shown in Exhibit 7-1):

1. Surrogate representative of the K-65 material and BentoGrout™ and the prescribed debris is placed in the surrogate tank inside Silo 4 to achieve sufficient depth of surrogate material to test the system (1 day's production).

2. The fan system simulating the RCS Phase II system is calibrated to match airflow and negative gas pressures in the silo headspace and the effects of equipment ingress and egress.

3. Using the sluicing nozzle and the slurry transfer pump suspended from the Silo 4 Support Structure and water staged in one of the TTA Storage Tanks, the surrogate is sluiced to the designated TTA receiving tank.

4. Decant water from the TTA Water Supply Tank is used to test and verify operation of the UF System. Decant water is transferred to the Filter Process Tank for feed to the filter. After passing through the UF System, the clean water is supplied to the High-Pressure Pump Skid by the Filtrate Tank and the solids containing water is returned to the Filter Process Tank.

5. After the bulk removal of the surrogate, the sluicing nozzle and slurry transport pump are replaced with the debris retrieval system and the CATS. The EMMA™ maneuvers the SREE to remove the surrogate simulated waste heel in the tank. CATS further dilutes the waste stream and pumps it to the TTA receiving tank. The shape of the Silo 4 inner surrogate tank provides a simulation of the tank from the center to the walls. The removed surrogate is allowed to settle in the TTA receiving tank.

6. Discrete objects in the surrogate tank will be reduced in size as necessary using the SDRS cutter and shall be removed using EMMA™ and the Debris Removal System basket.

7. EMMA™ will demonstrate its ability to wash down and decontaminate the silo dome and walls and to spray a fixative using arm-mounted nozzles.

8. Contamination of the SWRS is simulated to demonstrate effectiveness of the installed decontamination equipment (EMMA™ and the decontamination spray rings).

9. Using the TWRS slurry pump, the settled surrogate in the TTA tank is sluiced from the tank through the existing TTA pipeline and diverted to Surrogate Settling Tank for slurry dewatering. After the surrogate material dewatering requirements have been satisfied, the material is radiologically surveyed to determine disposition. If the material meets free release criteria, then the material can be disposed of in a landfill. If the surrogate material is contaminated, then Fluor Fernald designates a disposal location. The separated water is discharged to ground drainage or the FEMP wastewater system as deemed appropriate by Fluor Fernald.

10. Steps 2 through 9 are repeated as required for SOT.

5.0 AWR PROJECT SUPPORT SYSTEMS AND COMPONENTS

This section provides design descriptions for the AWR Project support systems and components. First, the AWR Project distributed control system (DCS), including its concept, installation and utility requirements, and descriptions of equipment or component features is provided in Section 5.1. Secondly, Section 5.2 provides detailed descriptions of various AWR Project system components, including the decant pump, high-pressure pump skid, TTA decontamination pump skid, slurry pump and CATS, and the oil hydraulic power supply.

5.1 Distributed Control System

The AWR Project DCS is an integrated system that allows both local control at the equipment site and remote control at the central control trailer station. The AWR Project DCS supports operations during FSMS testing and SWRS, DWRS, FDS, and TWRS waste removal operations.

5.1.1 System Concept

The AWR Project DCS is a PLC-based system with distributive I/O data collection and control nodes. The PLCs and redundant operator HMI stations are located in the control trailer. The data collection and control nodes are currently located at the Silo Bridge, high-pressure pumps, and the TTA building. The distributive I/O data collection and control nodes are connected to the PLCs by a fiber optic network. The individual equipment items located at the I/O nodes are connected to the nearest I/O node with field wiring. Both the RCS and the TTA Sampling System are equipped with self-contained PLC controllers.

5.1.2 Installation Requirements

The AWR Project DCS is modular in design. Most of the AWR Project DCS is installed on the mechanical equipment. The DCS components required for the TTA are designed for field installation at the FEMP site. To ensure the DCS works with the TTA equipment upon installation in the TTA building, proper interface documentation control is required. The interface documentation control is required to ensure the PLC and HMI programming agrees with the I/O connections and operating expectations of the TTA equipment when the TTA equipment is connected to the TTA I/O node.

5.1.3 Utility Requirements

The following utilities are required to support the AWR Project DCS. Additional utility requirements are described in latter portions of this section that relate to specific equipment or components.

> ***Electrical Power***—UPS 120-V AC, single-phase power is provided to the AWR Project control trailers. UPS 120-V AC, single-phase power is provided to each I/O data collection and control node. 120-V AC power, single-phase is provided to the AWR Project control trailers.

Fiber Optic—Fiber optic cables are installed to the required I/O nodes located throughout the site. The fiber optic cables can support three ring networks. Spare feeds of fiber optic lines are provided.

Interfaces—Interfaces to equipment systems include the EMMA™ System and the Gripping End-Effector, the RCS, SWRS, TWRS, SREE, and SDRS.

Maintenance—The required maintenance on the AWR Project DCS is low. Low maintenance is the result of using quality components and a modular design within the AWR Project DCS.

5.1.4 DCS Equipment Descriptions

In addition to the functions and requirements stated in the *Design Criteria Package*, Document No. 624-P622-03, for the AWR Project, the AWR Project DCS is designed incorporating the following general requirements:

- Safely control the equipment,
- Protect the operator,
- Allow remote operation of the equipment,
- Easy to learn and operate, and
- Reduced maintenance.

The following information is the description of the control system from the conceptual review session. As the design is finalized, the control system will be modified as required to support any changed requirements.

5.1.4.1 Control Trailers

Two control trailers are used for the AWR Project. One control trailer is used to support the FSMS testing, training, and operations. The second control trailer is used to support Silo 1 and 2 waste removal operations. Each control trailer has an operator station for the control of the waste removal support equipment. This operator station does not include the EMMA™ controls, as EMMA™ has a separate and adjacent operator station. The control trailers have wiring distribution for field 120-V AC power and UPS 120-V AC power.

5.1.4.2 FSMS Operations

FSMS test operations are performed first. The FSMS testing provides a means to test the equipment, train operators in equipment use, conduct a training session in waste removal from Silo 4, and perform the FSM ICAT/SOT.

5.1.4.3 Operator Stations

The operator station in the control trailer (either FSMS or silos) provides a central location for controlling and monitoring the equipment at the Silo Bridge and the TTA building. The selected PLC system is based on the Siemens central processor unit (CPU) Simatic S7-414-2DP. The CPU directly supports the Process Field Bus (Profibus) network standard. The CPU supports 32,768 channels of digital I/O and 2,048 channels of analog I/O. The CPU has 384K bytes

RAM program statements. The CPU memory has battery backup to prevent loss of the operating program and data. The CPU is equipped with a real-time clock.

The PLC and the data/control I/O modules are networked on the Profibus. The Profibus network allows the data collection and equipment control to occur remotely in the field and away from the PLC. The Profibus network greatly reduces the amount of I/O field cabling required to support the PLC operations. Each CPU will have its own 10-amp, 24-V direct current (DC) power supply. The UPS power supplies electrical power to the CPU power supply. The CPUs and its power supply are mounted on a Deutsches Institut Normung (DIN) rail inside a cabinet to minimize dust accumulation.

The programming of PLC and I/O interface development is performed with the Siemens STEP 7 Development System. The STEP 7 has user-friendly functions for phases of an automation project including: configuration and parameterization of hardware, definition of communication, programming, testing, starting up, servicing, documentation, archiving, operation, and diagnostics functions. STEP 7 supports ladder diagramming, function block diagramming, and statement lists programming methods.

Other software used in the development of the PLC controller includes Continuous Function Chart (CFC) and Sequence Function Chart (SFC). The CFC software supports hardware devices (i.e., variable frequency motor drive) that directly connect to the Profibus. The SFC supports graphic creation of sequence control and operation of equipment. Other Siemens software may become required as the needs of the operating equipment become more defined.

The STEP 7 software operates on the PC-based programming computer. The programming computer is located in the control trailer near the CPU. The connection from the PC to the CPU is by way of the Profibus network connection on the CPU. The PC computer may be identical to the computers used for the HMIs.

Installed Spares—The PLC system has 25% installed spare for memory and digital and analog I/O channel count. The I/O modules that are mounted within the field I/O nodes use no more than 75% capacity of the module to provide for the 25% installed spare I/O channels.

EMMA™ Interface—The requirement for the field PLC to monitor and record alarms from the EMMA™ system requires a connection from the field PLC to the EMMA™ controller. The EMMA™ controller consists of three Siemens PLCs. Because only one PLC can be the master on the Profibus network, the EMMA™ controller cannot be on the same Profibus network as the field PLC. The connection between the EMMA™ PLC master and the field PLC is performed using six digital outputs to EMMA™ PLC and six digital inputs from EMMA™ PLC. The EMMA™ PLC archives its own operating information.

Operator Station I/O—An I/O node is required to support the operator devices at the operator station. The I/O node consists of SM 421 digital input module and SM 422 digital output module connected to the back plane of the S7-414-2DP CPU. Field termination blocks are used to connect the field wiring to the modules. The wiring from the field termination block to an module is equipped with a connector to the module. The connector is keyed to prevent terminating the connector into the wrong module. If a module needs to be replaced, then the operator removes this connector instead of disconnecting the entire field wiring from the module.

The selected digital I/O modules (with reservations to change) have 32 digital inputs and 32 digital outputs. The inputs and outputs are rated for 24-V DC. The modules are used to support the emergency stop (E-stop) control, the water sluicing nozzle joystick and vertical position control, water sluicing nozzle selection, and the Master Equipment Enable Switch (MEES) key.

Joystick—The sluicing nozzle position is controlled in the pitch and the yaw direction. A two-DOF joystick is used for controlling the pitch and yaw of the sluicing nozzle. The joystick is mounted at the operator's control station. The joystick is also equipped with a deadman switch that allows the joystick to only become active when the operator grasps it.

The sluicing nozzle vertical position is controlled with a hoist located inside the sluicing nozzle enclosure. The command signals for the hoist are governed by a three-position (up-stop-down) joystick equipped with a deadman switch. The hoist joystick is located near the pitch/yaw joystick. This design gives the sluicing operator direct physical devices to control the sluicing nozzle.

During the FSMS, there could be up to three sluicing nozzles in operation. During SWRS operations, only one sluicing nozzle operates and during TWRS operations, two sluicing nozzles operate. A single joystick will be installed at the operating station to operate sluicing nozzles. A three-way selector switch determines which sluicing nozzle the joystick will control. During SWRS, the silo sluicing nozzle position will be selected. During TWRS, the switch will be used to select one of the two sluicing nozzles installed in a TTA tank.

5.1.4.4 Human-Machine Interface

The operator HMI station consists of two PC-type computers operating graphic screens depicting equipment layout and operating status. From the HMI screens, the operators issue commands to control the equipment and view operating status of the equipment. Equipment operating parameters are set and changed from the HMI screens.

The two HMIs operate in a redundant mode. The redundant mode allows either HMI computer to perform display and control operations for the PLC system. When both HMI computers are operating, the operator uses either or both HMI computers to view operating status and control the field equipment. The two HMI computers are connected directly to the Profibus.

The Siemens WinCC Software Development System is applied to create the display and control screens for the two HMI computers. WinCC supports data trending and archiving with time-controlled and event-driven project reporting and documentation. WinCC supports alarm logging acquisition and archiving. Password protection is supported for limiting operator access for operating control limits. Each HMI computer requires a full software license for WinCC and the redundant support software license.

The PC computers for the HMIs must operate the Microsoft NT operating system. For this reason, the computer is equipped with one of the fastest processors available when the computers are purchased. A hard disk greater than 10 gigabytes and with a minimum of 64K of RAM is installed. The computers are Ethernet ready for networking to a printer. The computers are equipped with a read/write CDROM disk drive for archiving data. A Profibus

connection card (CP5412) is installed in each HMI computer to allow the computer to connect and have access to the Profibus. The color display screen is 19 inches or larger for HMI display. The computer is also equipped with a keyboard and mouse pointer device. HMI computers are powered from the UPS power within the control trailer.

RCS HMI—The RCS PLC is mounted on the RCS skid and the PLC is equipped with its own local HMI. A separate HMI for the RCS is located at the operator station. Communications between the RCS HMI and the PLC is with the Profibus network. If the RCS PLC is set up as a master, then the HMI needs a separate Profibus network from the field Profibus.

Portable Sampling Module—The portable Sampling Module is located in the TTA building and is equipped with its own PLC. The PLC runs its own program to automatically collect and log the samples from the waste in the TTA. The PLC needs to be in the slave mode to allow operation on the Profibus network the field PLCs are using. The field HMI displays and controls the operation of the portable Sampling Module.

General HMI Display Screen Layout—The top display screen shows the overall layout of the field equipment. This layout includes the equipment on the silo bridge, the high-pressure pumps, and TTA equipment. The screen shows the general operating condition of the equipment, especially the pumps and motor-operated valve (MOV) positions. Some information about tank levels and water pressures and flows are also displayed.

The operator clicks on a screen icon to pop up another screen to display detailed information about the equipment device(s). The information shown depends on the device(s). For example, clicking on the slurry pump will pop up a screen about the devices within the slurry pump enclosure including the MOVs. This pop-up screen allows the operator to start a motor or change a valve position.

Operating parameters are also changed within the device pop up display screen. Password protection is an option. Operating motors and pumps are displayed in green and the off condition is represented by red. Open valves are displayed in the green and closed valves in red. Alarms and warning messages are displayed on any screen displayed on the HMI computer.

5.1.4.5 Profibus Network Communication

The current network requires three separate Profibus networks. The first Profibus network is for the field PLC, the second Profibus network is to support the EMMA™ controller, and the third Profibus network is to support the RCS PLC. Fiber optics is used to connect the widely separated equipment I/O data nodes.

The three Profibus networks are configured for the ring topology. The ring topology imposes a redundant data path over the Profibus network. If a fiber optic cable is broken, then there still is a fiber optic path on the network for data travel. Every data I/O node requires the OLM/S4 copper-to-fiber converter. There are two ports for the fiber optic fiber and two copper ports to the I/O node equipment. The OLM/S4 supports the redundant ring topology.

The fiber optic cabling consists of two 62.5/125-glass fibers within the cable. The cable requires at least six fibers. The unused optic fibers become installed spares. The optic fibers are terminated with connectors directly into the OLM/S4 modules.

5.1.4.6 Master Equipment Enable Switch

The MEES is a PLC hardware protection system. The MEES has a key switch at the operator station in the control trailer that prevents equipment startup and operation unless the key is in the "Operate" position. When the key is in the "Operate" position, the PLC allows the HMIs or local control panels to control the equipment.

After an E-stop condition forces the equipment to stop operating and the E-stop switches are returned to the run position, the MEES must be turned to the "Off" position and then back to the "Operate" position to allow the field equipment to operate by way of the PLC and HMI. This control prevents an operator in the field from clearing an E-stop switch and accidentally starting equipment before conditions are ready for equipment startup.

5.1.4.7 Emergency Soft Stop

The soft stop control allows the operator to rapidly shutdown operating equipment (i.e., motor-driven equipment) at the Silo Bridge or the TTA. The soft stop commands are produced by the PLC, operators in the control trailer, or operators in the field. The PLC monitors the soft stop signals and upon detection of a soft stop command, the PLC will issue shutdown commands to the equipment.

The soft stop is intended to rapidly stop motor-driven equipment. If desired, the soft stop signal can be used to position equipment (i.e., MOVs) to a safe or known position. The PLC monitors and responds to an E-stop command.

5.1.4.8 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.4.9 Local Control

The PCL directs the local control of the field equipment. This method allows greater control of the equipment than that provided by hand switches and relays at the equipment locations. Control commands are provided with hand switches located on the local control panels.

The Hand-Off-Remote switch position "Off" will command the PLC not to start or operate the equipment from any command source. In the "Remote" position, the PLC will take commands from the HMI. In either case, "Off" or "Hand", an HMI alarm event is recorded.

5.1.5 Input/Output Nodes

The Sluicer, Slurry, Decant, and High-Pressure Pump I/O Nodes are the data collection and control point for the equipment devices. The I/O node requires an ET200M station with an

IM153 module and standard S7-300 I/O modules. This station forms a distributive I/O data collection and control node. The ET200M station can support a total of eight S7-300 type I/O modules. An I/O module is replaced within the station without removing power or affecting the operating status of the other I/O modules in the station.

If the I/O requirements for the bridge I/O is more than what one ET200M station can support, then a second ET200M station with I/O modules is added. The I/O requirements include the 25% installed I/O spare channel requirement. Generally, there are requirements for both digital and analog I/O modules. The digital I/O modules may include both DC and AC voltage I/O modules. The choices of digital I/O modules include SM321, SM322, and SM323 modules. There are also different models within each type of module. The choices of analog I/O modules include SM331, SM332, and SM334 modules. There are also different models within each type of analog module. The I/O modules are rated for a temperature range of 0 °C to 60 °C. The ET200M station is not weather-resistant. The station is housed in a heated National Electrical Manufacturers Association (NEMA) 4 enclosure. The enclosure may require air conditioning to keep the internal enclosure temperature below 60 °C (140 °F).

5.1.5.1 Profibus

The fiber optic link from the control trailer to the bridge I/O node terminates in the I/O node enclosure. At this location, the Profibus is converted back to a copper link using the OLM/S4 converter. Another fiber optic link links the bridge I/O node to the high-pressure pump I/O node. The Siemens IM153 module is required for the ET200M station to use the Profibus.

5.1.5.2 Power Supply

The ET200M station requires 24-V DC for operation. The select power supply is Siemens PS307 module and mounts on the DIN rail with the IM 153 module. The power supply requires 115-V AC power from the UPS. The power supply output is rated for 5 amps. The power supply supplies power to a limited amount of sensors and actuators. Additional power supplies are required for sensor and actuator requirements.

5.1.5.3 Power

The I/O node enclosure requires 115-V AC, single-phase, for enclosure heating, ventilating, and air conditioning (HVAC) and MOV power.

5.1.5.4 Enclosure

The instrument node enclosure has an environmental rating of NEMA 4 or better. Because of the heat-producing devices inside the cabinet, the cabinet may require air conditioning. The enclosure is equipped with a sun shield to reduce the sun heat load during the summer conditions. The enclosure has an internal heater to maintain warm internal cabinet temperature in cold weather conditions. The cabinet size will be as minimal as possible. The enclosure is equipped with a thermocouple to provide warning of excess high temperature inside the enclosure.

5.1.5.5 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.6 Sluicing Nozzle System

The sluicing nozzle system is designed to spray high-pressure water into the silo material to form a slurry mixture. The sluicing nozzle system consists of a pitch and yaw-positioning device on the nozzle. A hoist is used to lower and raise the nozzle into and out of the tank. The sluicing nozzle system has MOVs within the enclosure.

5.1.6.1 Sluicing Nozzle Pitch and Yaw Positioning

The sluicing water jet nozzle requires pitch and yaw position control. The Siemens IM 178-4 position controller module is a two-channel positioning interface module. Two absolute encoders, mounted on the sluicing nozzle, provide the nozzle's pitch and yaw position inputs to the interface module. The SM 338 reads the actual position values cyclically from the absolute encoders to pass the values onto the PLC by way of the Profibus.

The PLC receives the current pitch and yaw nozzle positions from the interface module over Profibus and the joystick positions at the operator station. The PLC finds a new commanded position (encoder position) for the nozzle and sends the commanded positions to the analog output module over Profibus. The analog output module generates an analog command to the motor drive amplifier.

The pitch and yaw motors and motor drive amplifiers are Electro-Craft devices or similar equipment. The final torque output of the motor gearbox may be as high as 400 foot-pound. The nozzle requires a positioning velocity of 0 to 10 degrees per second. The final motor and motor amplifier selection coincides with the mechanical design progression. The absolute encoders are Siemens devices equipped with synchro-serial interface. The positioning resolution is 0.09 degrees. The encoders will connect directly to the SM 338 module.

5.1.6.2 Sluicing Nozzle Vertical Positioning

A commercial two-speed winch is used to control the vertical height of the sluicing nozzle. In local operation, the hoist has two speeds. In remote operation (i.e., HMI operation), the hoist will be limited to the slow speed. An analog positioning sensor measures the vertical position of the nozzle mast. The sensor output is measured in the Bridge I/O node.

5.1.6.3 Motor Operated Valves

The MOV located inside the sluicing enclosure are controlled by the Sluicer I/O node. Limit switches mounted on the valve determine the valve's position. The valve motor actuator and the limit switches require 120-V AC power. Output modules (installed in the Bridge I/O node) control MOVs, support small ac drive motor loads, and input modules that monitor ac sensor

values. The motor drive power that is supplied by the AC output module is fuse protected. The fuses are located in the Sluicer I/O node enclosure.

5.1.6.4 Motor Starter

To allow the PLC to remove AC power from the pitch and yaw motor drive amplifiers and from the hoist, a motor starter is used to supply power to the amplifiers and hoist. The motor starter provides a method to remove power from the motors for normal shutdown or soft stop shutdown. The motor drive amplifiers and the hoist are fuse protected. There is a lockable disconnect switch in-line between the motor starter and the 480-V AC, three-phase power.

5.1.6.5 Control Enclosure

A NEMA 4 or better enclosure is required to house the disconnect switch, motor starter, pitch and yaw motor drive amplifiers, hoist motor controller, and interface circuits. The enclosure requires both heat and air conditioning to maintain proper operating temperature inside the enclosure. The control enclosure is mounted to the outside on the sluicing enclosure.

5.1.6.6 Cable Handling Inside the Enclosure

The cables that pass from the control enclosure to the Sluicing Enclosure will pass through sealed bulkhead fittings. The cables from the control enclosure to the hoist and MOVs travel direct to their devices. The cables (motor and encoder) for the sluicing nozzle are stored on a cable reel. The cables are pulled off the cable reel as required when new mast sections are installed to lengthen the sluicing nozzle mast. After the new length of cable from the cable reel are attached to the new mast section, the cable connectors on the cable reel end are reconnected to the cable connectors from the control enclosure.

5.1.6.7 Local Control

A Hand-Off-Remote switch is located on the control enclosure. In "Remote" position, the control of the equipment within the sluicing nozzle enclosure is controlled by the HMI. In the "Off" position, the PLC does not accept any commands to operate equipment within the sluicing nozzle enclosure. In the "Hand" position, the PLC accepts commands from the local I/O node control panel. In the "Hand" position, equipment within the sluicing nozzle enclosure is placed into local control. The equipment includes the pitch and yaw nozzle motors, the nozzle hoist, and MOVs.

5.1.6.8 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.7 Bulk Waste Retrieval/CATS System

The bulk waste retrieval/CATS system is the equipment used to pump the material out of the silos and to the TTA tanks.

5.1.7.1 Slurry Pump

The slurry pump is required to operate at different speeds to control the amount of slurry that is pumped out of the silo. A variable-speed motor driving through a gear reducer governs the slurry pump. A variable-speed motor drive powers the motor. The operator in the control trailer controls the speed of the pump by adjusting the speed of the pump motor.

The current selected variable-speed motor drive is a Siemens MidiMaster Vector drive with the Profibus connection. The motor drive is controlled directly by the PLC over the Profibus network. This variable-speed motor drive is sensorless. These features make this motor drive attractive.

The slurry pump motor is rated at 50-hp. The motor drive requires 480-V AC, three-phase power. Local control of the pump motor is provided by the front panel controls located on the motor drive amplifier. An ultrasonic level sensor is mounted above the slurry pump intake to determine the level of slurry present at the pump intake. If the slurry amount or level is low, then the sensor will detect the low-level and turn the slurry pump off.

The slurry pump vertical height is controlled by a motor-driven elevator platform. A single-speed motor driving lead screws in each of the corners of the elevator platform positions the elevator platform vertical height. The elevator platform height can be controlled either from the HMI or locally. The position of the elevator platform is measured and displayed on the HMI. A bi-directional motor starter controls the elevator motor. The motor requires three-phase, 480-V AC power.

5.1.7.2 Motor Operated Valves

The three MOVs located inside the slurry pump enclosure are controlled by the Slurry I/O node. Limit switches mounted on the valves determine the valve's position. The valve motor actuator and the limit switches are 120-V AC power.

5.1.7.3 Motor Starter

To allow the PLC to remove AC power from the slurry pump motor drive and from the elevator platform, a motor starter is used to provide power to the motor drive and elevator platform motor. The motor starter provides a method to remove power from the motors for normal shutdown or soft stop shutdown. There is a lockable disconnect switch in-line between the slurry pump motor drive and the 480-V AC, three-phase power.

5.1.7.4 Control Enclosure

A NEMA 4 or better enclosure is required to house a disconnect switch, motor starter, elevator motor controller, and interface circuits. The enclosure requires both heat and air conditioning to maintain proper operating temperature inside the enclosure. The control enclosure is mounted to the outside on the slurry pump enclosure.

5.1.7.5 Cable Handling Inside the Enclosure

The cables that pass from the control enclosure to the Slurry Pump Enclosure pass through sealed bulkhead fittings. The cables from the control travel directly to their devices.

5.1.7.6 Local Control

A Hand-Off-Remote switch is located on the control enclosure. In "Remote" position, the control of the equipment within the slurry enclosure is controlled by the HMI. In the "Off" position, the PLC does not accept any commands to operate any equipment within the slurry pump enclosure. In the "Hand" position, the PLC accepts commands from the local I/O node control panel. In the "Hand" position, equipment within the Slurry pump enclosure is placed into local control. The equipment includes the slurry pump motor, the elevator, and MOVs.

5.1.7.7 Profibus Equipment

A slurry flow meter sensor is installed in the slurry pump enclosure. The flow sensor connects directly to the Profibus network, which provides information generated by the flow sensor to the HMI.

5.1.7.8 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.7.9 Other Equipment

Six radiation detectors are supplied for use on two silo risers. The radiation detectors are stand-alone equipment and provide their own input device and monitor in the control trailer.

5.1.8 High-Pressure Pump I/O Node

The High-Pressure Pump I/O Node or I/O Node 2 is the data collection and control point for the equipment devices located on or near the high-pressure pumps. The I/O node requires an ET200M station with an IM153 module and standard S7-300 I/O modules. This station forms a distributive I/O data collection and control node. The ET200M station supports a total of eight S7-300 type I/O modules. An I/O module is replaced within the station without removing power or affecting the operating status of the other I/O modules in the station.

A second ET200M station with I/O modules is added if the I/O requirements for the bridge I/O is more than what one ET200M station can support. The I/O requirements include the 25% installed I/O spare points requirement. Generally, there are requirements for both digital and analog I/O modules. The digital I/O modules may include both DC and AC voltage I/O modules. The choices of digital I/O modules include SM321, SM322, and SM323 modules. There are also different models within each type of module. The choices of analog I/O modules include SM331, SM332, and SM334 modules. There are also different models within each type of analog module. The I/O modules are rated for a temperature range of 0 °C to 60 °C. The ET200M station is not weather-resistant. The station is housed in a heated NEMA 4 enclosure.

The internal enclosure temperature may require air conditioning to keep the temperature below 60 °C (140 °F).

5.1.8.1 Profibus

The fiber optic link from the bridge I/O node terminates in the high-pressure I/O node enclosure. At this location, the Profibus is converted back to a copper link using the OLM/S4 converter. Another fiber optic link links the high-pressure pump skid I/O node to the TTA I/O node. The Siemens IM153 module is required for the ET200M station to use the Profibus.

5.1.8.2 Power Supply

The ET200M station requires 24-V DC for operation. The selected power supply is Siemens PS307 module and mounts on the DIN rail with the IM 153 module. The power supply requires 115-V AC power from the UPS. The power supply output is rated for 5 amps. The power supply provides power to sensors and actuators. Additional power supplies may be required for sensor and actuator requirements.

5.1.8.3 Power

The I/O node enclosure requires 115-V AC, single-phase power for enclosure HVAC and MOV power.

5.1.8.4 Emergency Soft Stop

The soft stop cable is intended to rapidly stop motor-driven equipment.

5.1.8.5 Enclosure

The I/O node enclosure has an environmental rating of NEMA 4 or better. The enclosure is equipped with a sun shield to reduce the sun heat load during the summer conditions. The enclosure has a heater to maintain warm internal cabinet temperature in cold weather conditions. The I/O node enclosure is mounted to the outside of the high-pressure pump skid cover. The enclosure is equipped with a high-temperature switch to provide warning of excess high temperature inside the enclosure.

5.1.8.6 Hardware Interface Connections

Wire termination will be accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.8.7 High-Pressure Water Pumps

The three water pressure pumps can be started and stopped from the HMI. The pump discharge flow is dumped or directed to the using device. The pump discharge pressure to the using device is controllable. The pumps' operating information and discharge water pressure is displayed on the HMI. The water pressure pumps supply water to the SREE cutting jets, to the jet pump, and to the riser decontamination spray rings.

INFORMATION ONLY 3157

5.1.8.8 Hydraulic Pressure Pumps

The hydraulic pump supplies hydraulic operating pressure to the SREE rotation motor and the debris-cutting shear. From the HMI, the pump can be started and stopped, and operating conditions are monitored.

5.1.8.9 Motor Starter

Each motor has its own motor starter allowing the PLC to control the starting and stopping of the high-pressure pump motors. The motor starter is controlled from the high-pressure I/O node. There is a lockable disconnect switch in-line between the motor starter and the 480-V AC, three-phase power.

5.1.8.10 Control Enclosure

A NEMA 4 or better enclosure is required to house the disconnect switch and the pump motor starter. Each motor has its own enclosure near the motor the enclosure is controlling. The enclosures do not require heat or air conditioning.

5.1.8.11 Local Control

A Hand-Off-Remote switch for each pump is located on the high-pressure I/O node enclosure. In the "Remote" position, the control of that high-pressure pump and associated control equipment is controlled by the HMI. In the "Off" position, the PLC does not accept any commands to operate equipment associated with that pump. In the "Hand" position, the PLC accepts commands from the local control panel. In the "Hand" position, equipment associated with the high-pressure pump is placed into local control. The equipment includes the starting and stopping of the pump, position of the dump valve, pressure adjustment, and pressure reading. The control commands are performed at the hand-held local controller.

5.1.8.12 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.9 TTA I/O Node

There are up to 14 I/O nodes with in the TTA for data collection and control point for the equipment devices located in or near the TTA building. Each I/O node requires an ET200M station with an IM153 module and standard S7-300 I/O modules. This station forms a distributive I/O data collection and control node. The ET200M station supports a total of eight S7-300 type I/O modules. An I/O module is replaced within the station without removing power or affecting the operating status of the other I/O modules in the station.

Generally, there are requirements for both digital and analog I/O modules. The digital I/O modules include both DC and AC voltage I/O modules. The choices of digital I/O modules include SM321, SM322, and SM323 modules. There are also different models within each type of module. The choices of analog I/O modules include SM331, SM332, and SM334 modules.

There are also different models within each type of analog module. The I/O modules are rated for a temperature range of 0 °C to 60 °C. The ET200M station is not weather-resistant. The station is housed in a NEMA 4 enclosure.

5.1.9.1 Profibus

The fiber optic link terminates at the Sample Valve Box node enclosure. At this location, the Profibus is converted back to a copper link using the OLM/S4 converter. Another fiber optic link links the FSM Diverter Equipment Box node back to the Operator Station I/O node. The Siemens IM153 module is required for the ET200M station to use the Profibus.

5.1.9.2 Power Supply

The ET200M station requires 24-V DC for operation. The selected power supply is Siemens PS307 module and mounts on the DIN rail with the IM 153 module. The power supply requires 115-V AC power from the UPS. The power supply output is rated for 5 amps. The power supply provides power to a limited amount of sensors and actuators. Sensor and actuator requirements may demand additional power supplies.

5.1.9.3 Power

The I/O node enclosure requires115-V AC, single-phase power for enclosure HVAC and MOV power.

5.1.9.4 Emergency Soft Stop

The Decant, Sluicer, and Slurry control nodes are equipped with soft stop controls.

5.1.9.5 Enclosure

The instrument node enclosure has an environmental rating of NEMA 4 or better.

5.1.9.6 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.10 Decant Pumps

The decant pump is a single-speed pump and is used to pump tank liquid from the TTA waste storage tank to the silo sluicing nozzle. The pump floats on the water surface of a TTA waste storage tank when the pump is operating. There are two independent decant pump systems.

One decant pump is in Tank A and the other decant pump is in Tank B during SWRS operations. When the second silo SWRS operations are ready to begin, the decant pumps move to the second set of A and B tanks in the TTA building. Currently, the decant pump motor is rated at 60-hp. The motor requires 480-V AC, three-phase power. The decant pump lowers

into the waste TTA storage tank using two hoists located on the ceiling of the decant pump enclosure.

5.1.10.1 TTA I/O Node Control Motor Operated Valves

The MOVs located inside the decant pump enclosure have limit switches mounted on the valves determined the valve's position. The valve motor actuator and the limit switches may be 120-V AC power.

5.1.10.2 Motor Starter

The decant pump motor has a motor starter in a control enclosure mounted to the decant pump enclosure. The motor starter is controlled by the PLC. The motor starter also provides a method to remove power from the motors for normal shutdown or soft stop shutdown. There is a lockable disconnect switch in-line between the motor starter and the 480-V AC, three-phase power.

5.1.10.3 Control Enclosure

A NEMA 4 or better enclosure is required to house the disconnect switch and motor starter. The enclosure does not require heat or air conditioning. The control enclosure is mounted to the outside on the decant pump enclosure.

5.1.10.4 Cable Handling Inside the Enclosure

The cables that pass from the control enclosure to the Slurry Pump Enclosure pass through sealed bulkhead fittings. The cables from the control enclosure to the MOVs travel direct to their devices. The cables for the decant motor are stored on a cable reel quipped with a slip ring.

5.1.10.5 Local Control

A Hand-Off-Remote switch is located on the control enclosure. In "Remote" position, the control of the equipment within the decant enclosure is controlled by the HMI. In the "Off" position, the PLC does not accept any commands to operate equipment within the decant pump enclosure. In the "Hand" position, the PLC accepts commands from the local hand-held control panel. In the "Hand" position, all equipment within the decant pump enclosure is placed into local control. The equipment includes the decant pump motor and MOVs located inside the decant pump enclosure.

5.1.10.6 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.11 TTA Sluicing Nozzle System

The sluicing nozzle system is designed to spray high-pressure water into the TTA waste storage tank material to form a slurry mixture. The sluicing nozzle system is identical to the sluicing nozzle system used on the silos and is used to support the TWRS operations. During TWRS operations, two sluicing nozzle systems are installed into one TTA waste storage tank. The sluicing nozzle system's controls are identical to the sluicing nozzles used in the silos.

5.1.12 TTA Bulk Waste Retrieval

The TTA bulk waste retrieval system is the equipment used to pump the waste material out of the TTA tanks and to the Future Full-Scale Remediation Facility. The TTA bulk waste retrieval system control is identical to the Silo bulk waste retrieval system.

5.1.13 TTA Building Equipment

The TTA building equipment that is controlled by the TTA I/O node includes the three-way and two-way MOVs and liquid transfer pumps. The TTA I/O node also monitors the pressure and flow sensors within the TTA system.

5.1.13.1 Motor Starters within the Motor Control Center

Presently, there are three motor control centers located near the TTA building. TTA I/O node controls the motor starters using the Actuator Sensor Interface network or a new I/O node outside the TTA building.

5.1.13.2 Local Equipment Control

Each motor in the TTA has its own Hand-Off-Remote switch located on the TTA I/O node enclosure. Each MOV is controlled by its own Hand-Off-Remote/Position switch.

5.1.13.3 Hardware Interface Connections

Wire termination is accomplished with Phoenix Contact products or similar products. Field wiring to the I/O modules connects to terminal interfaces and not directly to the I/O module. Phoenix Contact provides products for DIN rail wire termination, fuse holders, relays and relay holders, and other DIN rail products.

5.1.14 Radon Control System

The RCS has its own redundant PLC for control. This PLC is located at the RCS Building and is equipped with a Profibus communication interface communicating on Fiber Optic Ring 3. The local RCS HMI communicates with the RCS PLC and provides both monitoring and control operations for the RCS. A different Profibus network for the RCS PLC is set for communication with the RCS HMI located in the control trailer. The PLC will provide HVAC data from modules to the RCS PLC system through this Profibus network as well as changes in setpoints from the RCS HMI in the control trailer. For FSMS testing, an RCS simulator PLC will control and test the airflow from Silo 4 to demonstrate controlling silo pressure.

5.1.15 Portable Sampling Module

The portable Sampling Module is controlled by a small, independent PLC for its own monitoring and equipment control. The PLC is located on the Sampling Module. This PLC is equipped with a Profibus communication interface and may communicate on Fiber Optic Ring 1. The PLC is set as a slave device on the Profibus network, and share Profibus Network 1.

5.2 System Components

This section provides descriptions of system components associated with the AWR Project. To some degree, each subsection provides descriptions of operations, equipment, and controls related to the respective AWR Project system component.

These system components include:

- Decant Pump System,
- High-Pressure Pump Skids,
- TTA Decontamination Pump Skid,
- Sluicer System,
- Slurry (Bulk Waste Retrieval) Pump/CATS, and
- Hydraulic Power Supply System.

5.2.1 Decant Pump System

The decant pump system is used to supply water to the silo sluicer water cannon. The pump system enclosure is mounted on the TTA equipment deck directly over the 48-inch riser centrally located on each storage tank. Two pump systems are provided. After the two pumps remove the supernate from two tanks, they are moved to the two remaining tanks, and remove the supernate from them. The decant pump system contains all the equipment needed to operate the pump, and interfaces with the TTA.

5.2.1.1 Supernate Pump Assembly

The pump assembly consists of one 60-hp centrifugal pump mounted on a float. The float has two pontoons, 22-inches diameter by 60-inches long, connected by a spring loaded folding frame 48-inches long when opened. The pump suction strainer will extend about 1-foot below the water level in the storage tank.

5.2.1.2 Enclosure

The enclosure is built with a structural steel tubing frame, and steel sheet metal welded to the frame. It has one airtight access door, one equipment pass-through, and sufficient gloveports and windows to allow equipment maintenance. The enclosure contains the equipment needed to allow the supernate pump to function. Equipment includes two 1-ton hoists to install and remove the pump from the tanks, one hose reel to hold the pump discharge hose, one cable reel to hold the pump motor wiring, and two 3-way ball valves and piping to direct the supernate and slurry flow. The enclosure also contains a spray ring to decontaminate the pump assembly

when it is removed from the tank. The local control box for the electric components and motors is located on the outside wall of the enclosure.

5.2.1.3 Installation

The enclosure is pre-assembled at the time of delivery to the AWR Project site. It is moved to the proper location on the equipment deck using air bearings. The riser connection on the bottom is attached to the 48-inch riser boot by a band clamp, and the enclosure is leveled and bolted to the floor. The utility interfaces are connected and tested.

5.2.1.4 Deployment

The pump assembly is hoisted into the tank using the two hoists located in the top of the enclosure. The assembly is installed in two parts, the float assembly, and the pump and mounting plate assembly. The float assembly is folded to pass through the 48-inch diameter riser on the top of the storage tank. Once the float is in the water, the spring force will unfold it. The pump and mounting plate are then lowered into the tank and placed on the float. The guide pins on the float properly position the pump.

5.2.1.5 Operation

The pump is operated as needed to supply water to the sluicer water cannon. During normal operation, the pump is remotely controlled from the TTA control room. The valves in the enclosure allow the operator to flush out the slurry piping as needed. As the tank fills with settled solids, the cable and hose are decontaminated and retracted onto their respective reels. The pump is raised up to the riser when slurry is being pumped to the tank.

5.2.1.6 Retraction

The system disassembles in reverse order from the way it is assembled, with the exception of the pump, and the spray ring decontaminates float assemblies before they are removed from the riser.

5.2.1.7 Control Approach

The pump operates either remotely or locally. The remote control console is located in the TTA control room. The operator controls the pump, hoists, and the valves from there. The operator receives feedback from the system by way of the sensor/transmitters on the pump, valves, and the E-stop switch. The system is locally controlled from a local control panel that contains pump and valve switches, and the E-stop switch. The hoists and any other powered equipment are operated locally.

Controls determine the level of the pump based on the supernate level in the tank. The level indicator determines both the surface and residue interface. Low-level shutoff of the pump is approximately 3 feet above that interface. The amount of water is calculated to ensure sufficient water is available to operate a day's sluicing.

5.2.2 High-Pressure Pump Skids

Three high-pressure pumps are provided to generate pressurized water for decontamination water to the decontamination spray rings, motive water to the jet pumps and cutting water to the SREE. The three pumps are mounted on one skid and enclosed. A local control panel is located on the outside of the enclosure. Quick disconnects for the high-pressure water supply lines are mounted at the enclosure interface. The enclosure has a footprint of 15 feet long by 7 feet wide by 1 foot high with an approximate weight of 15,000 pounds.

The equipment provided with the system consists of three high-pressure pumps: the decontamination water, jet pump motive water and SREE cutting water supply pumps. These pumps are housed in a heated and ventilated enclosure that includes the following: (1) three high-pressure pumps, (2) a lube water system collection pan, (3) a sump pump located in the sump, (4) process valves, piping and hoses, (5) a fresh air vent, (6) an exhaust fan, and (7) an enclosure heater to prevent freezing.

5.2.2.1 Equipment Description

The enclosure is constructed of insulated fiberglass walls and roof attached to a floor/support frame structure. The floor/support is fabricated of welded and painted carbon steel. Forklift points as well as a grounding lug are integrated in the support frame. Liquid leaks inside the enclosure are contained and collected in a sump located in the floor of the enclosure. A sump pump will be provided that will transfer any liquid to the water supply tank. The sump pump is an air-operated, double-diaphragm pump.

The high-pressure pump for the decontamination water supply is the Butterworth Liqua Blaster, Model 103ET, or equivalent. This pump has the capability to supply up to 40 gpm at 3,000-psi discharge pressure. This pump is a three-piston, positive-displacement pump constructed of stainless steel, carbon steel, and cast iron. A 480-V, 3-phase, 75-hp, totally enclosed, fan-cooled (TEFC) electric motor drives the pump.

The cutting water and motive water pumps are identical systems. Each pump is the Butterworth Liqua Blaster Model 110ET. Each pump has the capability to pump up to 10 gpm at 10,000-psi discharge pressure. These pumps are three-piston, positive-displacement pumps constructed of stainless steel, carbon steel, and cast iron. A 480-V, 3-phase, 75-hp, TEFC electric motor drives each pump.

The lube water from each pump drains into a common collection tank supplied with an air-operated, double-diaphragm sump pump to transfer the liquid to the process water tank. The fresh air vent and the exhaust fan provide air circulation inside the enclosure. Louvers with a replaceable steel mesh screen over an opening in the enclosure wall will from the fresh air vent. A 110-V motor powers the exhaust fan. The fan is equipped with movable louvers to prevent heat loss during cold weather. A thermostat-controlled, 1,500-watt heater powered by 110-V power prevents system freezing during cold weather.

5.2.2.2 Operational Description

Equipment inside the enclosure is installed before delivery to the site. A forklift positions the system on leveled and compacted gravel or a concrete pad located on the ground. Three-

phase, 460-V AC and 110-V AC electrical service will be connected at the disconnect switch, that also contains the power distribution panel. The process water supply and return lines and the high-pressure supply lines connect at their respective quick-disconnects.

Process water is supplied to the high-pressure water supply system at 40 gpm and 50 psi. The water supply line enters the enclosure and divides into three separate supply lines to each pump. Each line has a hand operated valve to manually shut off the water. The pump supply lines also have local flow and pressure instrumentation. The low-level pressure switch interlocks with the power to the pump, turning off the pump when the pressure of the incoming supply water drops below the predetermined level.

Each pump has a pressure-relief valve to protect the pump from over pressurization. The crankcase lube gauge on the pump has a low-level switch that shuts off power to the pump. The lube water gravity drains to a common lube water collection tank where a sump pump returns the liquid to the water supply tank. This return line from the collection tank has backflow preventers. The discharge line from each pump has an air-operated dump valve that—when closed—diverts the water supply to the return line. The return line from the dump valve has flow instrumentation and back flow preventers. The differential of this return flow and the inlet flow indicates the high-pressure water supply flow. This flow rate is monitored remotely.

The pressure is controlled remotely with the air-operated control valve or locally with the manually operated control valve. When the pumps are started up, the dump valve returns the water to the supply tank, the manual valve is closed and the remote valve is opened. When high-pressure water is needed, the dump valve opens, allowing the water to pass through the remote pressure control valve. As this valve closes, the water is forced down the supply hose. The pressure is monitored remotely. For manual operation of the pumps, the manual control valve is opened and the remote control valve is closed upon start up. As the dump valves open, the water passes through the manual valve. Local instrumentation allows operations to monitor the pressure as they close the manual valve.

5.2.2.3 Controls

The pumps operate either locally or remotely. The local control panel mounts on the exterior of the enclosure and has pump status lights, start/stop buttons, dump supply/auto switch, dump valve status lights, and an E-stop button. In local operation, pressure is controlled with the manual pressure-controlling valve. The local pressure indicator provides feedback to the operator to monitor discharge pressure. In remote operation, the manual pressure control valve is fully closed. The pressure is controlled from the remote graphical control console by inputting the desired discharge pressure and using the pressure transmitter and pressure controller for closed loop control. The remote console displays discharge pressure and dump valve status.

System interlocks shut down the pumps in the event of low inlet pressure, high discharge pressure, low crankcase lube level, high discharge flow, or high liquid-level in the sump. Enclosure temperature control (i.e., heater and exhaust fan) is provided by thermostats located in the enclosure and is not integrated with the local control panel or remote console. A lockable electrical disconnect switch will be mounted at the local control panel.

5.2.3 TTA Decontamination Pump Skid

One high-pressure decontamination pump provides support to the decontamination spray ring operation in the TTA. The pump will be mounted on a skid weighing up to 5,000 pounds and having a 4-foot by 6-foot footprint. Nonskid mounted piping, hoses, valves, fittings, and instrumentation are included as part of the TTA decontamination pump skid system.

5.2.3.1 Pump

The single decontamination pump for service in the TTA is a positive-displacement, piston-type pump with water lubrication. The pump provides 3,000 psi and 40 gpm at the pump discharge. This pump uses a 75-hp motor requiring 460-V, three-phase power. The high-pressure pump is skid mounted and capable of local operation from the local panel or remote operation from the central control console. The pump has a pressure-relief valve, pressure indicator, pressure transmitter, pressure controller (for remote operation), and a manual pressure control valve (for local operation). The pump is mounted to a painted, carbon steel skid without any leak collection or detection capabilities, and operates indoors without any freeze protection provisions. The pump also meets seismic, floor loading, and building ventilation requirements. Inlet piping (< 200 psi) meets the requirements of ASME B31.3, and outlet piping meets the requirements of ASME B31.3 or the Water Jet Technology Association.

5.2.3.2 Controls

The pump is operated locally or remotely. The local control panel, mounted to the skid, has pump start and stop buttons, dump/supply/auto switch, dump valve status indicator lights, and E-stop. In local operation, pressure is controlled with the manual pressure-controlling valve. The local pressure indicator provides feedback to the operator to monitor discharge pressure. In remote operation, the manual pressure control valve is fully closed. The pressure is controlled from the central control console by inputting the desired discharge pressure and using the pressure transmitter and pressure controller for closed loop control. The remote console displays discharge pressure and dump valve status.

5.2.4 Sluicer System

The sluicer directs a concentrated stream of decant fluid to the waste surface and "pushes" a pumpable slurry toward the bulk waste removal pump. The sluicer deploys through one of the risers located 25 feet from the center of the silo. Using decant water supplied by the sluice water supply pump, the sluicer directs a concentrated water stream to the waste surface and provides a slurry to the retrieval pump. The sluicer system has three degrees of freedom: mast elevation, sluicing nozzle pan, and sluicing nozzle tilt. The sluicer system weighs approximately 15,000 pounds.

The sluicer system consists of the sluicer, its controls, and the enclosure. Sluicer components include the mast sections, mast hoist, mast support table, and sluicing nozzle assembly. The sluicer is controlled from either a local control panel or remotely from a graphical control console. The enclosure includes a small double-door pass through port (approximately 2-feet by 2-feet by 2-feet deep), a large double-door access hatch (approximately 3-feet by 3-feet by 11-feet high), a mast-handling trolley, and numerous gloveports.

5.2.4.1 Equipment Description

Mast and mast hoist—The mast serves a dual purpose: supply feed water and power/signals to the sluicing nozzle and its controls, and support to the nozzle (and its reaction forces). To deploy the sluicing nozzle fully into the silo (41 feet from the bottom of the bridge to the silo bottom), the mast has four 9-foot long modular extensions in addition to the pan/tilt module. As the level in the silo decreases, extensions are added to increase the mast length. A hoist at the top of the sluicer housing remotely or locally controls mast elevation.

A roof-mounted trolley running from inside the double-door hatch and along the perimeter of the sluicer enclosure moves mast modules into and out of the enclosure. Spare modules will be stored at the end of the trolley run and suspended from the trolley. As extra modules are required to extend the mast reach, a module is rolled on the trolley to near the mast hoist and handed off to the mast hoist. The in-silo portion of the mast is locked to and suspended from the mast support table during the process of adding mast modules.

The mast is made of rectangular structural tubing. The mast module joints are self-aligning joints using high-strength fasteners to hold the joints in place. The mating edges of each mast section are machined to ensure a snug fit. A removable flange-type attachment is connected to the top of the deployed mast to prevent the mast from falling into the silo in the event of a catastrophic hoist or cable failure.

The sluicer fluid-supply hose is routed through the inside of the mast. The hose has quick-connect fittings at the mast joints for ease of connection. Power and signal cabling for the sluicer joint motors and encoders are routed outside of and attached to the mast sections. All these cables are bundled together. Extra cable is stored on a manually controlled motor operated cable reel. As a new mast section is added, the cable reel pigtail is disconnected and enough cable is deployed from the reel to attach to the new mast section. The bundle is clamped to each mast section approximately every 3 feet. There is a section of hose and cable bundle suspended between the topmast section and the inlet piping inside the enclosure. This suspended section has enough slack to allow full mast elevation travel without binding the hose or cable bundle. When sufficient cable is deployed and attached, the cable reel is locked and the pigtail connected.

Mast Support Table—The mast support table guides the mast radially during sluicing operations. Cam rollers are mounted to the table to guide the mast and support the reaction forces from the sluicing nozzle. While adding or removing mast extensions, the support table will support the in-silo portion of the mast and nozzle assembly.

Sluicing Nozzle Assembly—The sluicing nozzle assembly consists of the nozzle and the pan and tilt mechanisms. The nozzle is sized to optimize the sluicing stream delivered at the waste surface given the supplied flow conditions (nominally 300 gpm at 150 psi, less line losses from the pump). The pan and tilt mechanisms are electrically driven with position feedback to the remote control console. The nozzle is capable of directing flow from the horizontal position to approximately ±90°. The pan mechanism is capable of rotating the nozzle approximately ±170°.

Enclosure—The enclosure has a footprint of approximately 6 feet by 10 feet and is constructed of structural tubing with a sheet metal skin. Gloveports are located strategically at various

points on the enclosure including near the mast support table, the small pass through port, and the hose and cable connection locations as a minimum. A double-door access hatch allows large items to be moved into or out of the enclosure without breaking containment. The outside door is a single door. The inner door is a double-door (e.g., French doors) to minimize the space required to open the doors. A trolley rail runs inside the large pass through area. A second trolley rail runs in the main enclosure and around the periphery of the main enclosure. The trolleys are used to move mast extensions into and out of the enclosure and for mast extension storage. A hose and cable interface box attaches to the enclosure. Hoses and cables inside the enclosure terminate at the interface box with bulkhead connectors and quick-connects. A small double-door pass through port is provided to move smaller items into and out of the enclosure without breaking containment.

5.2.4.2 Operational Description

The initial condition of the sluicer system before beginning operations is with hoses and control/ power cables connected internally and externally. One mast module is mounted to the sluicing assembly and supported by the mast hoist. The sluicing nozzle is aligned with the mast to allow the assembly to pass through the silo riser into the silo. The other three mast extensions are stored in a corner of the enclosure hanging from the trolley. Doors and hatches are closed and latched. The operator sets mast position limits. The local/off/remote switch at the local control panel is set to "remote". From the remote console, the sluicer operator lowers the mast into the silo until the nozzle is at the desired operating position. The nozzle is directed to the desired location using the joystick controls at the remote console. The sluicer is ready for operation in this condition.

During sluicing, the sluicer operator continues to move the sluicing nozzle with the joystick controller to "push" slurry toward the bulk waste removal pump. The operator adjusts the nozzle elevation as required by lowering or raising the mast. When the lower limit of mast travel is reached, operations must cease to allow addition of another mast extension.

A locking support bracket is installed at the top of the in-silo mast extension to allow the mast to rest on the support table. The mast is lowered until it rests on the support table. The mast hoist is disconnected from the top of the mast and raised. A second mast extension is rolled on the trolley to near the mast hoist. The mast hoist is connected to the top of the second mast extension and the mast extension is released from the trolley. The second mast extension is lowered into place on top of the in-silo mast and fastened. Hose connections are made at both ends of the second extension and the cable bundle is extended and clamped to the outside of the second extension. The position limits are adjusted as necessary. Operations continue as previously described.

Retraction of the mast is a reverse process of the actions described above. The sluicing nozzle is aligned with the mast to allow it to pass up through the silo riser. Hoses and cables are disconnected. The mast is raised and mast extensions are removed and stowed on the trolley one at a time.

5.2.4.3 Control Approach

The sluicer operates remotely with local control available for the mast hoist. The hoist operates on three-phase, 480-V AC power supplied to a local panel. Remote operations are from a

control console inside the control room. A local control panel is provided at the sluicer enclosure. The local panel has a mast hoist up/off/down switch, sluicer control valve open/close switch, cable reel out/off/in switch, sluicer module local/off/remote switch, and E-stop button. Motor starter/contactor/amplifier, control power supplies, digital I/O cards, E-stop, and relays are mounted in the local cabinet. Lockable power-disconnect switches are provided at the local panel. The remote control console uses multi-screen, graphical user interface, and PLC-based control. The graphical sluicer screen shows sluice water pressure and flow, sluicer angles, and E-stop status. Specific interlock requirements are programmed. After acceptance testing, software control is offered. This same console supports remote control of the equipment provided.

The sluicer pan and tilt joints are driven with servomotors with encoders for position feedback to the remote console and closed loop control system. The pan joint 0-degree position directs the nozzle approximately toward the center of the silo. It is capable of rotation up to ±170°. The tilt joint 0-degree position directs the nozzle toward the bottom of the silo. It is capable of rotation up to at least +100° and –5°. Each of the joints is capable of velocities from 0.1 to 5 degrees per second in either the positive or negative direction. A joystick controller controls the sluicer joints from the remote console only (i.e., there is no local control for the joints). The sluicer operator inputs the desired joint velocity on the graphical control console and then uses the joystick to direct the nozzle spray. The graphical control console displays joint positions and position limit alerts.

Each of the joints has software-controlled position limits. These limits are set to prevent the operator from moving the joints outside the desired limits of operation and to protect the equipment. The software limits are controlled by the sluicer operator and accessed through the graphical control console by inputting a password.

The mast hoist is controlled either locally or from the remote console. A "Local/Off/Remote" switch located at the local control panel selects the point of control. With the switch in the "Local" position, the hoist is operated locally. An "Up/Off/Down" switch on the local panel controls the hoist. With the local switch in the "Up" position, the hoist moves up and in the "down" position, the hoist moves down. This switch is a "dead man" type switch so that if it is released, the switch returns to the "Off" position. With the local switch in the "Remote" position, the hoist operates remotely from the graphical control console. From the console, the operator selects the mast hoist and either lowers or raises the mast by selecting and holding the up or down arrow. The mast hoist has an adjustable limit switch to control the upper and lower bounds for mast hoist operation.

5.2.5 Slurry (Bulk Waste Retrieval) Pump/CATS

The slurry (bulk waste retrieval) pump/CATS system is incorporated into one system and consists of a single enclosure housing all equipment associated with the bulk waste retrieval and CATS system. The enclosure and equipment are mounted on the silo bridge structure. Also associated with the system but located on the bridge outside the enclosure is a local control panel for the system equipment. The bulk waste retrieval slurry pump is deployed vertically through the silo riser and is driven from a variable-speed drive motor coupled directly to the slurry pump. The pump and drive is supported from up to two 12-foot long mast sections. The mast sections include hose jumpers providing slurry discharge, slurry recycle/flush water, SREE hydraulic water supply/return, SREE cutting jet high-pressure water, and heels removal

jet pump motive high-pressure wand. The overall weight of the slurry pump/CATS system and support equipment is estimated at approximately 18,000 pounds. The space requirement for the slurry pump and deployment/operational equipment is an approximate 9-foot by 18-foot footprint by 20-feet high.

The bulk waste retrieval and CATS system include the following equipment: (1) a progressive cavity (Seepex) pump; (2) a deployment mast assembly with external hoses and piping; (3) a vertical positioning table for vertically changing pump elevations; (4) variable-speed control pump drive motor and gear box, (5) a mast section stowage trolley, (6) a spray ring for decontamination of equipment; (7) process valves, piping, and hoses; (8) provisions for stowage and deployment of the SREE hose bundle; and (9) heel waste surge tank for collection and transfer of heel waste.

5.2.5.1 Equipment Description

Pump—The slurry pump is a progressive cavity pump. The pump is a Seepex, Model 130-12BN. It has the capacity to pump up to 500-gpm water at 100-psi discharge pressure. The pump normally operates at approximately 300 rpm at 350 gpm. The pump and gear motor are approximately 130 inches long. The pump assembly weighs approximately 2,300 pounds. The pump assembly is mounted from one or two 12-foot long mast sections in a vertical orientation. A strainer basket/can assembly is mounted on the suction end of the pump with the strainer being approximately 24 inches in diameter. A carbon steel pump housing, Buna-n stator, and hard-coated stainless steel rotor are necessary for this application. The system design is periodically evaluated for other materials that might better suit the slurry properties.

Pump Support Mast—The pump is supported from the motor end in a vertical-mounting configuration because of the size restrictions of the silo riser vertical access. The mast is in two 12-foot long sections constructed of 10-inch pipe. The sections are fabricated out of thick section material and have machined connection flanges with locating dowel pins to maximize alignment and minimize vibration. Each shaft section includes: (1) two 3-inch hose jumpers, one for the slurry discharge and one for sluice/slurry water recycle; (2) two high-pressure (10,000 psi), ½-inch inner diameter (ID) hoses for the SREE cutting jets and the jet pump motive water; and (3) two hydraulic hoses for the SREE drive motor. The uppermost shaft section is attached to a vertical positioning table with a travel of approximately 2 feet more than the shaft section length. A variable-speed drive motor coupled to a gearbox is mounted to the slurry pump and drives the slurry pump. The motor is approximately 50 hp and operates in a range of 0 to 300 rpm.

Elevation Table—The elevation table is constructed of a flat plate on that the slurry pump mast assembly mounts. The plate is fitted with four direct couple screw linear actuators driven by an open loop, remotely controlled, single-speed AC drive motor. A level instrument/encoder remotely displays the table elevation. Software interlocks on the basis of the table level signal maintain limits for the top and bottom of the table travel. The gearboxes, drive shafts and couplings, and drive motor are mounted to the structural steel frame members of the enclosure.

Mast Section Trolley—The mast section stowage trolley is mounted on the side of the enclosure and is of dual crane rail-type construction. The trolley has the capacity to store the mast sections. The trolleys are free rolling, non-motorized, and fitted with attachments for hanging the mast sections vertically. The trolley assembly of the monorail has a rotating boom

section on the end that can extend under the elevation table and transfer the mast sections from the elevation table to the trolley. The trolley has travel stops at both ends.

Enclosure—The equipment enclosure is constructed of welded and painted carbon steel. It generally uses a structural tube exterior frame with a carbon steel sheet metal skin welded to the structural frame members. The frame includes anchor points, lifting eyes, and grounding lugs. Because of the excessive time and cost required for full PPE dress-out activities inside the enclosure, gloveports and viewing windows are located in areas where routine work is required. Routine activities include adding or removing mast sections, routine maintenance of valves and instruments, passing small items (less than 1 cubic foot and 50 pounds) into the enclosure, and performing decontamination with the hand-held spray wand. A large, controlled ventilation vestibule is provided for personnel access to the inside of the enclosure or insertion/removal of large equipment. A supplied air connection is provided for the enclosure as well. Gloveports and windows are capable of attaching steel cover panels to them if required for missile protection. The enclosures include piping penetrations for attachment of inlet ventilation, decontamination water, and other utilities such as compressed air. Waterproof, bulkhead-type electrical connectors attach electrical services. Each enclosure includes a spool piece on the bottom for attachment to the silo/tank risers. A spray ring is located near the bottom of the enclosure as a part of this spool piece. The floor of the enclosure is designed to drain decontamination water into the risers.

Hose Bundle—A hose bundle approximately 75-feet long supplies utilities to the SREE and heel waste jet pump. SREE utilities (water hydraulics and high-pressure cutting water) are attached to the SREE at one end of the hose bundle. The other end of the hose bundle attaches to the pump mast at the heel waste surge tank section that connects to the bottom of the pump. The hose bundle includes a waste conveyance hose with the jet pump incorporated in-line. The waste conveyance hose is 2-inches ID on the suction and discharge of the jet pump. The SREE hydraulic supply hose is ½-inch ID and the return hose will be ¾-inch ID. The SREE and jet pump high-pressure water hoses will both be ½-inch ID. An abrasion sleeve surrounds all the hoses in the hose bundle. The enclosure incorporates a hose bundle reel capable of deploying and retracting the hose bundle. When the hose bundle is stowed on the reel, the jet pump is removed and replaced by a flexible jumper of the same length. As the bundle is deployed, the jet pump is installed in line, as that section of bundle is unspooled.

5.2.5.2 Bulk Waste Retrieval Mode

Installation—The bulk waste retrieval equipment is located within a single enclosure. Equipment inside the enclosure, including wiring, instrumentation, and piping and the decontamination spray ring are positioned and installed before delivery. After rotating the bridge in place over the silo, the enclosure is coupled to the silo riser opening by removing the blind flange on the flexible boot below the spray ring and bolting the flange to the flange on the silo riser. Blind flanges are removed from the double-walled process piping interface point and the secondary containment for the piping is attached to the mating flange on the enclosure. Using the glove access at the process piping connection point, blind flanges are removed from a flexible jumper on the process piping in the enclosure and the jumper is bolted to the bridge mounted secondarily contained process piping. Single-walled piping is attached with mating quick connects, and/or flanges, and/or screwed piping connections.

Deployment—The enclosure is delivered with the slurry pump suction strainer coupled to the elevation table. The elevation table is positioned at the upper end of its travel. At the start of deployment, the pump is lowered into the silo riser by lowering the elevation table to its lower position. The pump suction is still several feet above the waste in the silo at this point. A support slides into place around the upper end of the pump at this point. The support is capable of supporting the weight of the pump and all mast sections combined. Once the upper end of the pump assembly is secured, it unbolts from the elevation table assembly and the elevation table raises to the upper end of its travel. A mast section, suspended from the mast section trolley at the top of enclosure, rolls into place under the elevation table assembly. The table lowers until the top of the mast section can be coupled and bolted to the table. The table then lowers again until the lower end of the mast section is bolted to the pump assembly. The slide is then released from the pump and retracted from over the riser opening. The pump lowers further into the silo adding additional mast sections until the pump suction encounters the waste determined by visual observation using the in-tank cameras. The 3-inch process hoses (slurry and flush/recycle) connect to the mast.

Operations—The slurry pump is lowered approximately 1-inch above the BentoGrout™ layer and its elevation noted by the slurry pump operator. Lowering and raising the pump occurs by remotely operating the elevation table from the control station located in the control room. The slurry pump suction rises approximately 2 feet above the level of the top of the BentoGrout™ layer. The sluice water is directed though the sluicer under suction of the slurry pump and will sluice in an area approximately 6 feet in diameter. The slurry pump is lowered until the solids level switch is triggered. The pump is then started remotely and its speed remotely controlled to regulate the discharge flow rate or pressure. As the slurry pool level decreases, the pump is slowed, or stopped to maintain suction. If the pump is slowed to a point that there is risk of settling in the pipe, then the pump stops and the transfer line is flushed. Valving inside the enclosure allows the slurry transfer line to be flushed by diverting sluice water through the slurry transfer line. The valve and piping selection is such that the transfer line can be either forward or back flushed (depending upon valve line-up) using sluice water supplied from the decant pump system in the TTA. As sluicing proceeds, the solids level under the pump suction lowers as indicated by the solids level switch. The operator continues to lower the pump remotely until solids are encountered and the switch is made again. The solids content in the transfer line is remotely monitored during slurry transfer operations. The solids content is adjusted by adding sluice water to the slurry transfer line. The sluice water used to adjust the solids content is injected into the line by a 1-inch control valve located in the enclosure. The operator is required to closely monitor the discharge pressure of the slurry pump for indications of cavitation during operations. If cavitation is detected, signaled by erratic pressure fluctuations, the operator shuts the pump down and flushes the pump and transfer line.

The most likely place for solids plugging to occur is at the pump suction. Pump suction plugs are cleared by running the pump in reverse, or by blasting the suction strainer with the high-pressure spray ring mounted to it. Solids plugging occurring in the waste transfer piping is detected by increase in pump discharge pressure with no increase in pump speed or no significant change in solids content. In the event of a partial or total plug in the slurry transfer line, the valving in the enclosure diverts the pump discharge back through the mast to the silo while sluice water is used to clear the plug. Once the plug is cleared, the slurry is diverted back into the transfer line to resume normal operations.

Retraction—Retraction of the bulk waste removal pump fundamentally operates in reverse order of deployment except that the decontamination spray ring is activated during retraction of mast sections to ensure contamination inside the enclosures is kept as low as reasonably achievable (ALARA).

5.2.5.3 CATS Mode

Installation—The heel waste retrieval (i.e., CATS) mode associated equipment uses the same equipment described above (e.g., enclosure, slurry transfer pump, elevation table, process piping and valving, overhead trolleys). In addition, CATS also uses the following equipment: (1) an in-silo heel waste surge tank; (2) a hose bundle to provide high-pressure water and hydraulic drive supply utilities to the jet pump and SREE; (3) hose bundle handling equipment to aid in the deployment and retraction of the SREE/jet pump/hose bundle assembly, and (4) hose bundle support hoists located in the EMMA™ and sluicer enclosures to reduce hose bundle loading on the EMMA™. These items are installed in the enclosures after bulk waste retrieval is completed and the slurry pump is retracted and roughly decontaminated.

Deployment—Personnel working inside the enclosure performs the installation of this equipment into the silo. The SREE, attached to the end of the hose bundle, lowers through the riser while unspooling the hose bundle from its reel until the first hoist line attachment collar on the hose bundle is within reach of the EMMA™. While paying out hoist line from the hose bundle lift hoist located in the sluicer enclosure, the EMMA™ carries the hoist line hook to the collar and attaches it to the collar. The hoist then takes up cable as the remainder of the hose bundle is lowered into the tank. When only 10-feet of bundle remains on the reel, the end of the bundle is manually taken off the reel and attached to the couplings on the pump mast. The surge tank, slurry pump assembly, and mast sections are deployed into the silo in the same manner as used in bulk retrieval mode.

Operations—The waste heel removal begins in the area near the sluicer riser. At the start of heel removal, the sluice water decants from the TTA and diverts through the 3-inch flush/recycle line routed along the mast and into the surge tank in the silo. The slurry pump starts and its speed is adjusted to maintain the liquid-level in the surge tank. The high-pressure pump supplying the SREE is remotely started and the pressure adjusts to between 500 psi and 5,000 psi. The SREE rotation starts and adjusts to between 200 rpm and 500 rpm. The hose bundle hoist in the sluicer enclosure is remotely operated to raise the hose bundle out of the waste to allow the EMMA™ to move the SREE in the silo without dragging the hose bundle through the waste. The EMMA™ positions the bottom of the SREE at the waste surface and creates a slurry pool approximately 6 feet in diameter. Once the solids content of the slurry pool appears appropriate (10% to 50% solids), the high-pressure pump supplying the jet pump motive water is remotely started and the water pressure adjusted to between 6,000 psi and 10,000 psi creating suction through the waste hose in the hose bundle. The EMMA™ then lowers the SREE into the slurry pool and pumps the slurry though the jet pump to the heel waste surge tank. The slurry pump speed is adjusted to account for the additional flow into the hopper.

The EMMA™ continuously moves the SREE through the pool, expanding the pool depth and diameter until the hose bundle requires moving to another area of the silo. This operation continues until an area approximately 20 to 25 feet in radius from the sluicer riser is cleaned. When heel removal is complete in this region of the silo, the SREE is lifted into the air with the

jet pump operating to clear the waste hose of most of its water. The EMMA™ places the SREE on the floor of the tank in a cradle and detaches the hose bundle hoist cable extending through the sluicer riser. The sluicer-deployed hose bundle hoist cable is retracted and the EMMA™ grasps the hose bundle at one of the gripper collars located every 20 feet along the length of the hose bundle. The EMMA™ picks up a portion of the hose bundle and moves it to the edge of the uncleaned portion of the tank. The hose bundle hoist cable in the EMMA™ enclosure is deployed into the silo where the EMMA™ attaches it to the hoist attachment collar. The remainder of the heel waste is removed using the same method as described above.

Retraction—Retraction of the CATS equipment occurs in reverse order of the deployment while using the decontamination spray ring to perform gross decontamination of equipment before entering the enclosure.

Controls—The slurry pump is capable of being operated remotely or locally. The pump drive motor-operates on three-phase, 480-V AC power supplied to a local panel. A variable-speed motor controller is supplied with the pump motor and allows the pump motor to be operated at 1,700 to 0 rpm. The elevation table is controlled both locally and remotely and will be interlocked with the limit switch mounted on the pump suction that detects suction screen contact with the solid waste in the tank. The elevation table operation also interlocks with the upper and lower travel-limits. The hose bundle reel operates locally. The process valves (e.g., slurry, flush, recycle, and solids control) operate locally or remotely. Interlocks for these are to be provided.

Remote operations are from the central control console inside the control room. A local control panel is located at the Silo Bridge. The local panel provides a master on/off/auto switch, valve position switches, elevation table run switch, elevation table position display, hose bundle reel motor start/stop switch and a master E-stop button. Motor starter/contactor, control power supplies, digital I/O cards, E-stop, relays, and status lights are mounted in the local cabinet. A lockable power disconnect switch is positioned at the local panel.

5.2.6 Hydraulic Power Supply System

The hydraulic power supply system provides the hydraulic power needed by the SREE. The hydraulic portion of the system is based on a recirculating hydraulic system that runs on Shell Tullus hydraulic oil. A local control panel is located on the outside of the enclosure. Self-checking quick disconnects for the supply and return lines are mounted at the enclosure interface. The enclosure (that houses the 3,000 pounds per square inch, 5 gpm hydraulic pressure unit) has a footprint of approximately 4-feet by 4-feet and an estimated weight of 1,000 pounds.

The system consists of a weather enclosure with the following equipment located inside it: (1) a hydraulic pump; (2) a water reservoir; (3) an oil cooler; (4) a filtering system; (5) process valves, piping, and hoses; (6) a fresh air vent; (7) an exhaust fan; and (8) an oil reservoir heater to prevent freezing.

5.2.6.1 Equipment Description

The enclosure is constructed of fiberglass or sheet metal walls and roof attached to a floor/support frame structure. A door is provided in one wall for operator access to perform

operational checks and maintenance. The floor-support frame structure is fabricated of welded and painted carbon steel. Forklift points, as well as a grounding lug are integrated in the support frame. The space requirement for the enclosure is approximately 4-feet by 4-feet by 5-feet high. The estimated weight is 5,000 pounds.

A 460-V, three-phase, 10-hp, 1,725-rpm electric motor drives the pump. The pump/motor unit is capable of 3,000 psi at 5 gpm. The reservoir is a steel tank with a total capacity of 25 gallons. A tank-mounted unit contains monitors for temperature and level. The oil level can also be checked visually by a sight glass. The oil cooler will be an electric refrigeration unit. The filtering system is located in the return loop and includes a 10-micron cartridge filter. A pressure-relief valve vents the pressure back to the reservoir should over-pressurization occur.

The fresh air vent and the exhaust fan provide air circulation inside the enclosure. Louvers with replaceable steel mesh screen over an opening in the enclosure wall from the fresh air vent. A 110-V motor powers the exhaust fan. The fan is located in an adjoining wall to the fresh air vent and is equipped with movable louvers to prevent heat loss during cold weather. A thermostat controlled oil reservoir heater to prevent system freezing during cold weather is also powered by 110 V.

5.2.6.2 Operational Description

Installation—All equipment inside the enclosure is installed before delivery to the AWR Project site. A forklift positions the system on leveled and compacted gravel or a concrete pad located on the ground near the silo. Three-phase, 460-V AC and 110-V AC electrical service is connected at the disconnect switch that also contains the power distribution panel. Hydraulic hoses and a water supply line are connected at their respective quick-disconnects. As dependent systems connect to this system and the hydraulic lines are purged of air, the reservoir level is monitored to avoid a low-level shutdown.

Operation—The system will control hydraulic pressure from 500 psi to 3,000 psi. The system may operate in local mode or remotely. The system will be configured to control flow rate of oil to the SREE. Interlocked flow switches will automatically shut down the pump upon any hose break. A low-level switch on the reservoir will also be interlocked with pump operation.

5.2.6.3 Controls

The system operates either locally or remotely. The local control panel mounted on the exterior of the enclosure has pump status lights, a manual/off/auto selector switch, and a flow control adjustment switch. Also included in this panel are a motor starter/contactor, an E-stop, digital I/O cards, relays, and control power supplies. Power and signal cables external to the enclosure are provided. Remote operation is controlled by input from the central control system multi-screen, graphical user HMI that is PLC based. The screen offers system remote/local status, pump start/stop and run status, E-stop status, and flow rate control. Low-pressure, flow-achieved indications and reservoir temperature readout are also on this screen. This console provides remote control of the equipment.

System interlocks are provided to shut down the pump in the event of low reservoir level or high oil temperature. Enclosure temperature control for the exhaust fan is provided by thermostats

located in the enclosure and is not integrated with the local control panel or remote console. A lockable electrical disconnect switch is mounted at the local control panel.

INFORMATION ONLY

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Appendix E

INFORMATION ONLY

SILOS PROJECTS

ENVIRONMENTAL MONITORING PLAN
40000-PL-0010

Signature Page

Approved by:

K. Wintz, Silo 3 Project Team Coach	5/17/00 Date
P. Pimentel, Silos 1 and 2 AWR Project Team Coach	5/17/00 Date
D. Paine, FDF, Vice President, Silos Project	5/17/00 Date

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SILOS PROJECTS

ENVIRONMENTAL MONITORING PLAN
40000-PL-0010

TABLE OF CONTENTS

SECTION

1.0 General 1
2.0 Integrated Environmental Monitoring 1
3.0 Project-Specific Environmental Monitoring 1
3.1 Environmental Radiological Air Emissions Monitoring 2
3.1.1 The Silo 3 Stabilization Project and AWR Stack Monitoring Program 2
3.1.2 The IEMP Air Monitoring Program 2
3.1.3 The IEMP Environmental Radon Monitoring Network 3
3.1.4 Project-Specific Air Particulate Monitoring Program 4
3.2 Direct Radiation Monitoring 5
3.3 Wastewater Monitoring 5
3.4 Groundwater Monitoring 6
4.0 Reporting 6
5.0 References 7

ACRONYM LIST

ALARA	As Low As Reasonably Achievable
ARAR	Applicable, Relevant, and Appropriate
ASL	Analytical Support Level
AWR	Accelerated Waste Retrieval
AWWT	Advanced Waste Water Treatment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DOE	Department of Energy
FEMP	Fernald Environmental Management Project
HAMDC	Highest allowable minimal detectable concentration
IEMP	Integrated Environmental Management Plan
ISER	Integrated Site Environmental Report
OU4	Operable Unit 4
pCi	pico curie
SCQ	Sitewide CERCLA Quality assurance plan
TLD	Thermoluminescent Dosimeter
WAC	Waste Acceptance Criteria
WPRAP	Waste Pits Remedial Action Plan

SILOS PROJECTS ENVIRONMENTAL MONITORING PLAN

1.0 General

The current focus of environmental monitoring at the Fernald Environmental Management Project (FEMP) is the implementation of site-wide environmental monitoring and project-specific environmental monitoring. Site-wide environmental monitoring is addressed in the Integrated Environmental Monitoring Plan (IEMP) while project-specific requirements are addressed within the environmental control plans, process control plans, and other design documents which constitute the project's remedial design package. For the Silo 3 Stabilization Project and the Silos 1 and 2 Accelerated Waste Retrieval Project (AWR Project), modifications to the site-wide environmental program are necessary to support project activities. Therefore, the focus of this plan is to establish the integrated environmental monitoring requirements for Operable Unit 4 (OU4) during the conduct of both projects.

2.0 Integrated Environmental Monitoring

The IEMP focuses on monitoring air, direct radiation, groundwater, and surface water to ensure protection of human health and the environment during the conduct of site-wide remediation activities. The IEMP incorporates regulatory requirements for site-wide monitoring, trending, reporting, and it serves as the central reporting mechanism to the regulators and stakeholders for the ongoing emission control/ monitoring activities at the FEMP. It is important to note that Site-wide reporting under the IEMP does not preclude project-specific reporting for the Silo 3 Stabilization Project or the AWR Project.

3.0 Project-Specific Environmental Monitoring

Project-specific environmental monitoring requirements are identified in the applicable design documentation for both the Silo 3 Project and the AWR Project (References 1 and 2). Fluor Fernald Inc. has identified additional enhancements to the existing site monitoring program that are integral to both projects. As a result, this project-specific environmental monitoring plan documents the additional requirements addressing air, direct radiation, and project wastewater (i.e., slurry wastewater and decontamination wastewater) monitoring within and surrounding specified project boundaries that will be established by Fluor Fernald, Inc. The need and extent of project-specific monitoring has been evaluated based on the following criteria:

- Project complexity, extent of contamination, and scope;
- Applicable, Relevant, and Appropriate Requirements (ARARs) compliance strategy;
- DOE Orders compliance strategy; and,
- Existing monitoring data, modeling, and monitoring programs.

This project-specific environmental monitoring plan considers the location of the Operable Unit 4 (OU4) projects with respect to other remediation activities [e.g. the Waste Pit Remedial Action Plan (WPRAP) project] and the FEMP boundary. The plan also considers project-specific constraints such as the contaminants of concern; the characteristics of the OU4 wastes; and the material transfer, handling, and storage processes. Project-specific emission modeling of both normal and upset conditions have provided the basis for identifying and instituting process emission controls that are protective to the workers, public, and the environment (References 6 and 7). The effectiveness of the project-specific emission controls will be evaluated through analysis of monitoring results to identify whether increased or altered emission control methods are necessary. Project-specific environmental monitoring summary results will be provided in project completion reports.

3.1 Environmental Radiological Air Emissions Monitoring

Environmental radiological air monitoring during the Silo 3 and AWR Projects will consist of three programs: 1) the Silo 3 and AWR stack monitoring programs; 2) the IEMP Air Monitoring Program including the environmental radon monitoring network; and 3) the project-specific air monitoring program.

3.1.1 The Silo 3 Stabilization Project and AWR Stack Monitoring Program

The Silos 1 and 2 AWR Project stack monitoring requirements are described in the *Silos 1 and 2 Accelerated Waste Retrieval Project Remedial Design Package (Reference 2) and Operational Environmental Control Plan (Reference 3)*. The Silo 3 Stabilization Project stack-monitoring program is described in, RMR-0445-ENG-015-000, *Operational Environmental Control Plan* (Reference 4) and RMR-0445-ENG-024-000, *ARAR Compliance* Strategy (Reference 5). Both projects will deploy isokinetic sampling for particulate radionuclides, monitoring, and recording of stack exhaust that is compliant with Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H, and DOE Order 5400.5, Section IV.6.B. Additionally, the stack exhaust from both projects will be continuously monitored for radon to verify that emissions are controlled in a manner that will not cause the point source to result in a contribution to the fence line radon concentration of greater than 0.5 pCi/L, as an annual average above background. Radiological contaminants represent the primary contaminants of concern, therefore the focus of stack air monitoring will be for radionuclides; however, monitoring for other contaminants of concern will be added, as warranted.

3.1.2 The IEMP Air Monitoring Program

The IEMP Air Monitoring Program is an established program that will continue throughout remediation. Within the IEMP Air Monitoring Program, the radiological air particulate monitoring program provides fenceline the monitoring network for assessing the collective site-wide impact of FEMP multiple concurrent remediation activities. This program demonstrates FEMP compliance with all ARARs and provides early warning feedback

regarding the cumulative sitewide effectiveness of project-specific emission controls. The radiological air particulate monitoring program is reviewed annually in order to account for changes in remediation projects at the FEMP.

Additionally, within the IEMP Air Monitoring Program, the radon monitoring network has been designed to focus on monitoring Silos 1 and 2 headspaces, environmental radon levels in the vicinity of the silos, as well as radon levels at the site fenceline. In support of the Silo 3 and AWR projects and in anticipation of treatment of Silo1 and 2 material, the IEMP environmental radon monitoring network is being modified as described below.

3.1.3 The IEMP Environmental Radon Monitoring Network

During the Silo 3 Stabilization Project and the AWR Project, remediation activities directed toward the removal, processing, and storage of radon-generating wastes create the potential for the release of radon to the environment. Modifications and additions to the existing IEMP environmental radon monitoring network are necessary to accommodate construction activities associated with the AWR Project and to better monitor levels around the Silo 1 and 2 area during the OU4 remediation.

Three present radon monitoring stations near the K-65 Silos are to be re-located to accommodate construction activities. The monitoring stations to be re-located are as follows:

- KNW at the K-65 exclusion fence will be moved to the western side of the road, re-designated KNW-A.
- KSW at the K-65 exclusion fence will be moved to the western side of the road, re-designated KSW-A.
- T28 northeast of the K-65 exclusion fence will be moved across the road, in the prevailing wind direction from the K-65 Silos, re-designated LP3.

To better monitor radon levels in the K-65 area, five radon monitoring locations will be added to the existing IEMP radon network. The monitors will provide additional monitoring of radon levels in the vicinity of the silos during the Silo 3 and AWR projects and subsequent treatment operations for the Silos 1, 2, and 3 material. The tentative locations and designations for the monitors are:

- North of Silo 2 near the camera tower at the K-65 exclusion fence, designated KNO.
- South of Silo 1 near the new south camera tower, designated KSO.
- East of Silo 4 and in the prevailing wind direction from Silo 3, designated LP2.
- Southwest of the High Nitrate Storage Tank, near pole #543 at Trailer #117 designated T117.

INFORMATION ONLY

- An additional station was selected on the FEMP's west fenceline to supplement the established IEMP monitoring network. The monitor (PR-1) will be co-located with the WPTH-2 air particulate monitor, on the western perimeter of the facility.

The detail of the OU4 radon monitoring locations is shown on Dwg. 94X-5500-G-02259 (Attachment A). The map of the entire IEMP radon monitoring network is shown in Dwg. 94X-5500-G-SK-1051 (Attachment B).

Data from selected radon monitors will be accessible via a secure Internet address. The data will include the date and time of the most recent transmission, location, and latest radon concentration. This data will be sent from the monitoring instrumentation without review or validation. Data review and validation will be conducted in a manner consistent with the current methods used under the IEMP Fluor Fernald Inc. radon monitoring program.

3.1.4 Project-Specific Air Particulate Monitoring Program

The IEMP air particulate monitoring program, which is based on air monitors located at the FEMP's perimeter fenceline, provides early warning feedback regarding the cumulative sitewide effectiveness of all remediation project emission controls. The project-specific air particulate monitoring program will provide data that confirms the performance of the emissions controls used for the Silo 3 Stabilization Project and AWR Project. In addition to providing confirmatory data, the monitoring program will also provide data to quantify the nature and extent of releases from both projects in the event of an upset condition. The program will consist of four high-volume particulate air samplers that will be co-located with the radon monitors at the Bio-surge lagoon, LP-2, T117, and LP-15 locations shown in Dwg. 94X-5500-G-SK-1051 (A). These samplers maintain a consistent air sample flow rate between 40 and 50 cubic feet per minute through an 8 by 10-inch filter.

The sampling and analysis program will consist of bi-weekly isotopic thorium, radium-226, and total particulate analyses. Results from the isotopic thorium analysis (thorium-228, thorium-230, and thorium-232) will be used to specifically monitor Th-230, the primary isotope of concern within the Silo 3 residues. The radium-226 analysis will be used to assess the effectiveness of process-control measures during the Silo 3 and AWR projects. Total particulate analysis will be used to determine if the results are indicative of project emissions or reflect the measurement of fugitive emissions from other sources (e.g. dust from construction vehicle traffic).

INFORMATION ONLY

Samples will be analyzed according to the requirements for Analytical Support Level (ASL) B in the Sitewide CERCLA Quality (SCQ) assurance plan. The highest allowable minimal detectable concentrations (HAMDCs) for ASL B are 9.0 pCi/filter for isotopic thorium analyses and 4.0 pCi/filter for radium-226 analysis.

3.2 Direct Radiation Monitoring

In addition to airborne emissions, exposure to direct radiation is also a radiological hazard at the FEMP, particularly in the vicinity of Silo 1 and Silo 2. Direct, (a.k.a. penetrating) radiation is emitted from the radioactive materials stored onsite. The largest source of penetrating radiation at the FEMP results from the transformation of radium-bearing materials stored in Silos 1 and 2.

The IEMP environmental monitoring network includes thirty-two locations that monitor direct radiation levels associated with the storage of radionuclides at the FEMP. The monitoring is conducted using thermoluminescent dosimeters (TLDs). The monitoring network is well established and the locations were strategically chosen to ensure a monitoring envelope for each radiation source. During the AWR Project, major sources of direct radiation at the FEMP will undergo change. The operation of the Radon Control System (RCS) will result in elevated direct radiation adjacent to the carbon beds. The removal of the berm surrounding Silos 1 and 2 will result is changes to existing radiation shielding. These processes, together with the removal and relocation of the silo wastes to the Transfer Tank Area (TTA) will require an expansion of the IEMP TLD network to ensure adequate coverage of direct radiation sources.

The existing IEMP TLD monitoring network will be modified to take into account the relocation of the wastes stored in the K-65 silos. As necessary, current TLD locations will be adjusted and new TLD locations will be added to adequately characterize and monitor the direct radiation in the vicinity of the AWR project and the site fenceline. The background and technical justification for modifications to the IEMP TLD monitoring network will be provided through the IEMP annual review process.

3.3 Wastewater Monitoring

All wastewater from the Silo 3 Stabilization Project and AWR Project will be discharged to the FEMP Advanced Wastewater Treatment (AWWT) facility, if the wastewater characterization indicates the wastewater stream meets the AWWT WAC. If the WAC is not met, then pretreatment of the wastewater stream will be performed prior to discharge to the AWWT.

3.4 Groundwater Monitoring

Groundwater monitoring is currently managed by the Aquifer Restoration Project (ARP). The ARP provides the monitoring necessary to identify the effect of FEMP remediation activities. This monitoring is adequate for assessing potential impacts on groundwater quality due to the Silo 3 and AWR projects. In the event that collection of groundwater samples is needed to support the projects (or to assess any incidental releases), ARP managers will be notified to coordinate the appropriate groundwater monitoring activity.

4.0 Reporting

All project-specific environmental monitoring will be reported in the Silo 3 Stabilization and AWR Project Completion Reports, which will include a summary of the results generated during the projects. For radon monitoring, the report will identify each of the radon monitoring locations and the minimum, maximum, and average radon levels at each of those locations. For project-specific air monitoring, the report will identify each of the monitoring locations and the minimum, maximum, and average levels of each analyte at each of the locations. For direct radiation monitoring, the report will include TLD locations and a summary of quarterly results.

The project-specific monitoring data will not be included in the IEMP quarterly status or the Integrated Site Environmental Report (ISER) on a routine schedule. However, project-specific data may be reported as necessary in IEMP quarterly status reports and the ISER to explain significant changes in the data from the fenceline IEMP environmental monitoring program.

5.0 References

1) Fernald Silo 3 Project Remedial Design Package, RMR-0445-0081-000, Rocky Mountain Remediation Services, May 2000.

2) Silos 1 and 2 Accelerated Waste Retrieval Project Remedial Design Package, June 2000

3) Operational Environmental Control Plan for the Silos 1 and 2 Accelerated Waste Retrieval Project, June 2000.

4) Operational Environmental Control Plan, RMR-0445-ENG-015-000, Rocky Mountain Remediation Services, May 2000.

5) Applicable, Relevant, and Appropriate, Requirements Strategy, RMR-0445-ENG-224-000, Rocky Mountain Remediation Services, May 2000.

6) Preliminary Hazards Analysis Report for Silo 3, RMR-0445-0056-002, Rocky Mountain Remediation Services, January 2000.

7) Preliminary Hazards Analysis Report for the Silos 1 and 2 Accelerated Waste Retrieval Project, 624-P622-50, Foster Wheeler Environmental Corporation, January 2000.

3157

INFORMATION ONLY

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Attachment A

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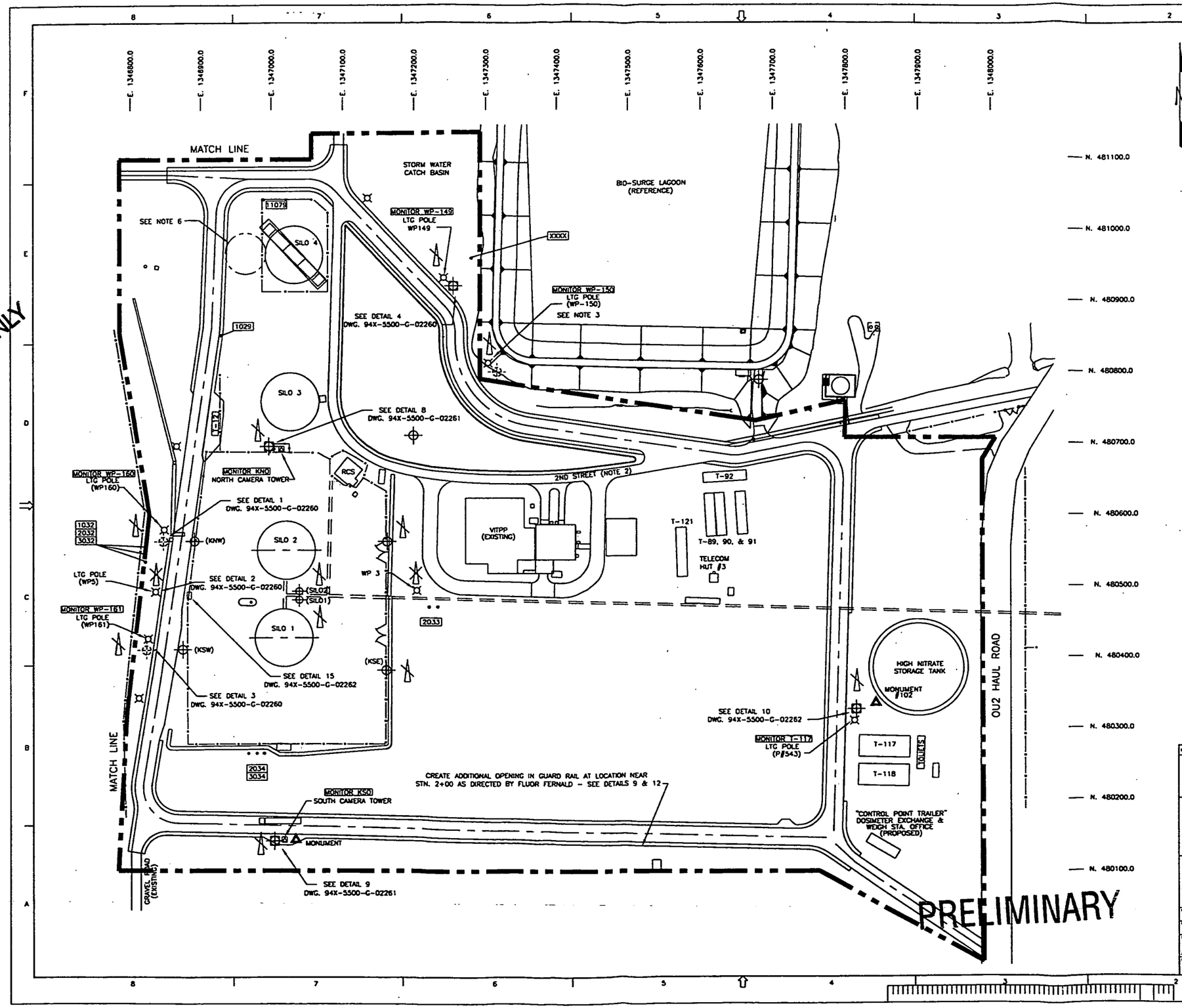

NOTES:

1. LOCATION OF FENCES, GATES AND CHECK POINTS TO BE DETERMINED.
2. THIS SECTION OF 2nd STREET TO BE USED BY PEDESTRIAN, LIGHT DUTY, OCCASIONAL DELIVERIES TO OU1, AND EMERGENCY TRAFFIC ONLY.
3. MONITOR, PAD AND POWER OUTLET FOR MONITOR AT WP-150 TO BE INSTALLED BY SILO 3 CONTRACTOR.
4. CONSTRUCTION AND OPERATIONS PERSONNEL WILL USE EXISTING SITE PARKING LOT.
3. PHASE I WORK CONSISTS OF INSTALLATION OF CONCRETE PADS, POWER AND NEW OR RELOCATED RADON MONITORS AND ALL ASSOCIATED SITE WORK AS SHOWN ON DRAWINGS 94X-5500-G-02259, 94X-5500-G-02260, 94X-5500-G-02261 AND 94X-5500-G-02262. PHASE II WORK CONSISTS OF INSTALLATION OF TRANSMITTERS, REPEATERS, HOSTS AND ASSOCIATED EQUIPMENT REQUIRED FOR MONITOR TELEMETRY.
6. EXISTING PRECAST 4'X4' CONCRETE PADS FOR USE AS PADS FOR THE MONITORS ARE LOCATED ON WEST SIDE OF SILO 4.
7. MONITORS AND INSTALLATION COMPONENTS ARE PERFORMANCE GRADE 4.
8. TRANSMITTERS AND REPEATERS ARE NOT PART OF THE PHASE I WORK PACKAGE. THEY ARE TO BE INSTALLED IN PHASE II.
9. CONTRACTOR SHALL EMPLOY EROSION CONTROLS AS REQUIRED TO MINIMIZE SOIL EROSION AND TO PREVENT SEDIMENT FROM LEAVING THE CONSTRUCTION SITE AS A RESULT OF THE CONSTRUCTION ACTIVITIES OF THIS PROJECT. EROSION CONTROL MEASURES SHALL CONFORM TO SECTION 02270 OF THE TECHNICAL SPECIFICATIONS.

LEGEND OF SYMBOLS

- ▲ = MONUMENT
- 1029 = MONITORING WELL NUMBER
- = EXISTING MONITOR LOCATION
- = RELOCATED MONITOR LOCATION
- = NEW MONITOR LOCATION
- = TRANSMITTER (PHASE II)
- = REPEATER (PHASE II)

000503

0 25 50 100 150 200 250
GRAPHIC SCALE
1" = 50'

PRELIMINARY DRAWING

DISPLAY: G_02259.DWG

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
FLUOR DANIEL FERNALD
SILOS PROJECT
CINCINNATI, OHIO

DRAWING TITLE
RADON MONITOR LOCATION
SILOS AREA LOCATION PLAN
OU 4 SILOS PROJECT

DRAWN BY: W. OVERHOLT	DATE: 1/18/00	CHECKED BY	DATE
FUNCTIONAL NO.: OU4	SCALE: 1"=50'		
SUBMITTED FOR APPROVAL	APPROVAL RECOMMENDED		
FDF PROJECT NO.: 40710	DRAWING NO.: 94X-5500-G-02259	SHEET NO.: 1	REV. NO.: B

DISTRIBUTION CODE: XXX 2/8 ACAD INITIALS: WJO DATE: 3/9/00

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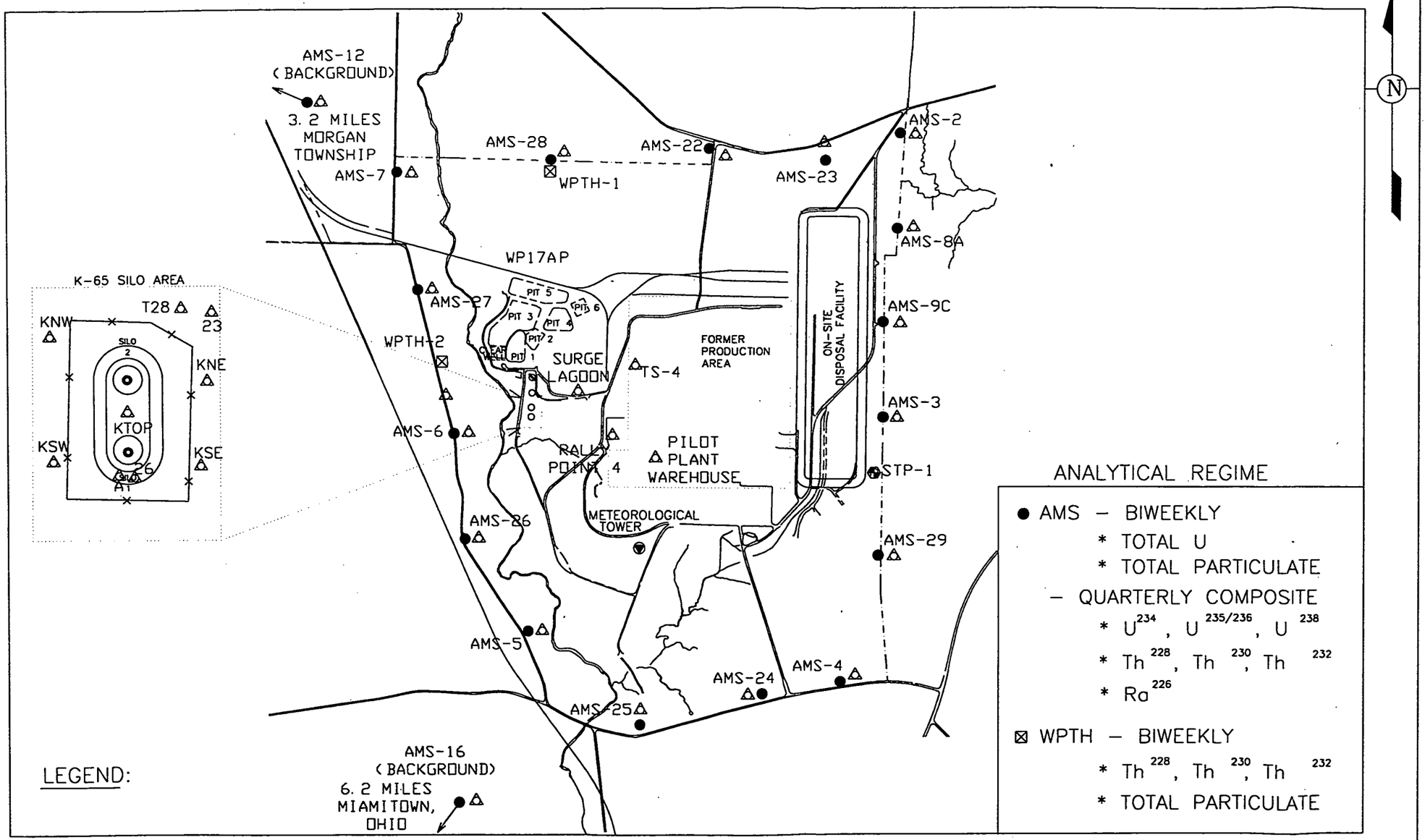
1

Attachment B

INFORMATION ONLY

RADIOLOGICAL AIR MONITORING LOCATIONS



\RAD\SK-1056.DWG
STATE PLANAR COORDINATE SYSTEM 1927

LOCATION MAP FOR AIR MONITORING LOCATIONS

Mar. 27, 2000

Appendix F

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

EASILY MANIPULATED MECHANICAL ARM (EMMA™) GENERAL INFORMATION

SUBMITTED TO:

FLUOR FERNALD, INC.

JUNE 2000

INFORMATION ONLY

3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SYSTEM DESIGN DESCRIPTION

DOCUMENT NO.
624-P622-30, Rev. 2

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

(EMMA™ MANIPULATOR SYSTEM)

SUBMITTED TO:

FLUOR DANIEL FERNALD (FDF)

CONTRACT NO. FSC 624

June 1, 2000

000507

TABLE OF CONTENTS

3157

1.0 SYSTEM OVERVIEW DESCRIPTION 1
1.1 Process Description 1
1.2 System Features 1
1.3 Design Criteria 5
1.4 System Interface Points 9
2.0 DEPLOYMENT TOWER SYSTEM 17
2.1 Tower Base 19
2.2 Z-Drive 19
2.3 Guide Rail and Guide Bearing Assembly 20
2.4 Maintenance Crane 21
2.5 RCS requirements 21
2.6 Airlock 21
2.7 Maintenance Floors 21
2.8 Utility Connections 22
2.9 Lighting 22
2.10 Painting 22
2.11 Spool Piece 22
3.0 ACTUATION PACKAGE 24
3.1 Outer Frame 24
3.2 Inner Frame 24
3.3 Azimuth Drive 25
3.4 Braking System 25
4.0 MAST 27
5.0 EMMA™ MANIPULATOR 28
5.1 Stages 1 through 3 29
5.2 Stages 4 and 5 29
5.3 Coupling Overview 30
5.4 Wrist 31
5.5 Sheath 31
6.0 INSTRUMENTATION & CONTROLS SYSTEM 33
6.1 EMMA Operation 37
6.2 Manipulator Control 39

000508

ACRONYM LIST

DOF	Degree (s) of Freedom
ACS	Arm Control System
ADSS	Arm Deployed Sluicing Subsystem
AICS	American Institute of Steel Construction
ALARA	As Low As Reasonably Achievable
ASCE	American Society of Civil Engineers
AWR	Accelerated Waste Retrieval
AWS	American Welding Society
CCTV	Closed Circuit Television
CD	Compact Disk
DMCS	Distributed Microprocessor Based Control System
DOE	Department of Energy
EMMA™	Easily Manipulated Mechanical Arm™
FAT	Factory Acceptance Testing
FEMP	Fernald Environment Management Plan
FF	Fluor Fernald
FMEA	Failure Modes and Effect Analysis
Foster Wheeler	Foster Wheeler Environmental Corporation
FSM	Full Scale Mockup
GEES	Gripper End Effector System
GUI	Graphical User Interface
HEPA	High Efficiency Particulate Air
HMI	Human Machine Interface
HVAC	Heating, Ventilation, and Air Conditioning
I/O	Input/Output
ICAT	Integrated Construction Acceptance Testing
LOS	Local Operating Station
OSHA	Occupational Safety and Health Administration
P & ID	Piping and Instrumentation Diagram
PC	Personal Computer
PID	Proportional, Integral, Derivative Controller
PLC	Programmable Logic Controllers
RAM	Reliability, Availability, and Maintainability
RCS	Radon Control System
ROS	Remote Operating Station
SREE	Silo Retrieval End Effector
SSC	Structure, Systems, and Components
SWRS	Silo Waste Retrieval System
TPG	The Providence Group
UL	Underwriters Laboratories
UPS	Uninterrupted Power Supply
VAC	Variable Alternating Current
VFD	Variable Frequency Drive

1.0 SYSTEM OVERVIEW DESCRIPTION

1.1 Process Description

The EMMA™ manipulator system is a major component of the Silo Waste Retrieval System (SWRS), and is critical to the success of the Accelerated Waste Retrieval (AWR) program. Two systems are planned for delivery to the Fernald Site. These systems will be used for the AWR operations on Silos 1 and 2, and the full-scale mockup (FSM) testing activities planned for Silo 4.

The EMMA™ manipulator system is designed to assist in all mining and silo closure operations from Bento-Grout removal through final inspection and fixative application activities. The proposed mining strategy will be achieved through effective employment of the manipulator. The manipulator will facilitate operations from initial entrance into the silo through final clean out, inspection, and closure acceptance. Waste and debris retrieval operations using the manipulator system is achieved by:

Deploying the high pressure Arm Deployed Sluicing System (ADSS) nozzles to breach the Bento-Grout layer and force the dislodged material toward the sluicing pump
Forcing the waste and debris away from the sluicing pump and Silo Retrieval End Effector (SREE) to facilitate continuous operations
Deploying the GEES camera and lighting system and ADSS to inspect and clean all wall-mounted silo sampling ports
Cleaning the in-silo cameras and lights to ensure optimum visibility for remote operations
Transferring debris to different locations in the silo prior to removal to minimize retrieval obstructions
Mobilizing bulk waste and debris from behind the sluicing pump and water cannon
Performing wall washing and inspection operations as the headroom within the silo is increased (eliminates need for high pressure water cannon on walls and minimizes the potential for silo damage caused by high pressure wall washing activities)
Forming debris piles for size reduction and removal activities
Strategically placing the debris size reduction tool off-center from the riser location near debris piles and providing a flat surface under the silo riser for placement of the debris collection and transport basket
Transferring debris from the pile to the size reduction tool to the retrieval basket
Providing close visual inspection capabilities throughout operations and final inspection
Employing the ADSS for fixative application
Employing the Gripper End Effector System (GEES) camera and lighting system to assist in initial and final wall, floor, and ceiling inspection activities

1.2 System Features

The manipulator is a 52.5 -foot long, 30-inch diameter (maximum), cylindrical serpentine manipulator composed of five independent stages and a wrist assembly. Stages 1 through 3 are single degree of freedom (1 DOF) stages, capable of bending only in a vertical direction (pitch). Stages 4 and 5 are two degrees of freedom (2 DOF) stages, and provide pitch and yaw capability, which allows the stages to bend both in vertical and horizontal directions. The 2 DOF

wrist at the end of the manipulator provides local dexterity for the GEES and ADSS, and other tooling provided for use in silo waste retrieval activities. The manipulator's length ensures access to the complete working envelope within the silo. The dexterity offered by the five discrete manipulator stages and wrist assembly enables the manipulator to move effectively around in-silo obstacles such as the SREE umbilical, the water cannon, and the slurry pump.

Ease of maintenance and Operations

Through the RAM (Reliability, Availability, and Maintainability) analysis, the expected reliability of our component was examined. Through this effort it has been determined that the manipulator will operate for 1000 hours with no scheduled maintenance activities. The probability for failure during this period is low. The failures rates used for this analysis were very conservative compared to the expectation for the part lifetimes. Repairs can be made during the non-operational periods. This was not considered in the RAM, but this type of repair would easily allow the system to operate for 1000 hours of operation before maintenance is required.

The control setup is very simple and intuitive. Operators have been trained in very short periods of time to use an EMMA™ system. The system that will be used at the Fernald silo is slightly more complex in that it has rotational and vertical positioning. A human machine interface (HMI) description has been included in this package. Ease of control has been the primary focus for the design of this system. Although a computer is used as part of the control system, an operator does not interface with this for normal operation. Ergonomically designed controls that exist such as levers, joysticks, or knobs are used to control EMMA's™ degrees of freedom.

The manipulator is designed so that insertion or extraction is not necessary at the end of each operation period. The arm can be left inside the silo environment. This decreases downtime during startup and shutdown, but will elminate the ability to perform work on the system during non-operational hours.

Key Capabilities

Perform waste retrieval activities in operating temperature ranges of 32°F to 100°F with humidity ranges from 10-100%. Temperature effects on the materials of construction and controllability have been examined, and it has been determined that the environment will not hinder the functionality of the system.

Manage, as a minimum, a 200-lb. payload at maximum horizontal reach (includes GEES and ADSS weight). All calculations have included this payload and the manipulator is designed to work with this load.

Provide ability to reach extreme areas within the silo. A 3D simulation has been implemented which provides the basis for manipulator length and ensures that the parts of the silo furthest from the inlet port can be reached. This analysis shows that the manipulator will be capable of reaching all points in the silo with the exception of those on the ceiling in the immediate area of the inlet port.

This system, when combined with the z- and azimuth-drives located in the deployment tower, results in a manipulator with sufficient dexterity and lifting capacity to carry out operations required for successful mission completion.

Equipment Safety and Survival

The EMMA™ manipulator system design incorporates unique coupling and cable systems that will allow the manipulator to safely sustain the in-silo rigors associated with operation and decontamination activities. The design also specifies robust materials of construction that will provide a 10-year operating life.

Several redundant systems have been included to ensure that control of the EMMA™ can always be maintained and that collision or loading of the silo does not occur. The system sensors will alert the operator to situations that could potentially damage the silo integrity, or cause a manipulator system failure. Programmed software controls will not allow the manipulator system to process forward movement or configuration commands should the manipulator encroach the designated safety space by the wall. Additional safety controls will be incorporated into the operating system to meet all operating requirements set forth by the silo environment and client-mandated operating requirements.

The EMMA™ manipulator system is a self-contained subsystem designed to meet safety factor requirements for operations at a nuclear facility. A System, Subsystem, and Component (SSC) Performance Grading (PG) exercise was performed in accordance with FF (Fluor Fernald) guidance to ensure system compatibility within the stated Silo environments. This analysis resulted in:

A PG 3 rating for the Deployment Tower structure. This structure reflects the highest risk component of the EMMA™ manipulator system with respect to seismic and wind loading stability, bridge interface, and potential worst-case failure scenarios. To minimize or mitigate risks associated with this structure, ASME/ANSI standards are being conservatively applied to the design and construction activities. Section 3.0 of this document identifies the specific risk areas and the approach employed to minimize or eliminate these risks.

PG 4 ratings were given to the remaining system equipment and components. The additional equipment/component designs are being prepared in strict accordance with applicable industry, DOE, and Fernald site codes and standards (identified in the Equipment Specification No. JS-GM-EMA-14-400).

Flexible coupling system—Elastomeric couplings are designed to provide the flexibility and recoverability required to meet the harsh operating conditions anticipated in the silo environment. These couplings will withstand the deformation caused by direct object impact, weight associated with deployment and transfer activities, changes in configuration required to reach all points within the silo, as well as temperature, humidity, and radiation operating environments. These flexible couplings are capable of regaining their original size, form, and functional abilities immediately following any event or combination of events stated above. This feature reduces maintenance and provides increased operating capability.

Redundant cabling system—The manipulator's actuation cables have been designed to meet a Safety Factor of 3. The cables have been selected and routed to provide durability and flexibility. Additionally, the design incorporates redundancy to accommodate a potential single failure so that effects to the operation, performance, and integrity of the system is minimized. In the unlikely event of a double failure, the manipulator will assume a slack, fully extended vertical posture that allows retrieval from the silo. Under no circumstances will the arm fail in a position that prohibits extraction, or allows it to contact and damage the silo. Wrist design will also reflect a failsafe system to ensure that the manipulator can be retracted from the silo.

Component and materials of construction selection—All components and materials of construction meet the operating environment and safety and sustainability requirements. For example, the deployment tower will be constructed of A-36 carbon steel (minimum ¼" thickness) to resist potential buckling and fracture risks. This material is painted to protect against corrosion for the duration of the retrival operation. Additional components and materials considerations include: operating system redundancies which provide 99 percent system availability; stainless and aluminum manipulator components that resist corrosion in the silo environment; sheath material that withstands 3,000 psi decontamination water spray; and a rigid mast segment constructed to prevent buckling under operational loading limits.

Personnel Safety

The Tower and EMMA™ system were designed to minimize the amount of time a worker(s) would need to be in the hazardous areas. This system was designed with ALARA as a guiding principle. Other methods of insertion are available with the EMMA™ system. However, the vertical tower deployment allows for the most reliability and least hands on operation.

Maintenance activities will be performed in the deployment tower structure from the appropriate maintenance platforms. Labor intensive maintenance such as stage, segment, or major change outs will be done at a staging area provided outside of the silo area. The design and procedures will address maintenance efficiencies under both nominal and off-normal events.

OSHA guidelines were followed that ensure appropriate specification of equipment and layout of space in the tower module. This includes safety climbs, door sizes, workspaces, and confined space considerations.

Efficiency of maintenance workers was considered during the RAM and several measures have been taken to ease worker strain while inside the confined spaces of the tower. Floors have been included in various locations that allow for rest points while climbing. Floors fold out allowing access to the manipulator. This allows a much more comfortable and safe platform for performing work. The manipulator and associated actuation package locks down so that a redundant system ensures no suspended loads above workers.

Modifications to Prelminary Designs

Due to the change in the location of the silo inlet hole, a re-evaluation of the needed manipulator length and tower height was done. This was performed to minimize the risks due to the height

and weight of the tower structure. The tower height in the final design will be 90 feet tall. The manipulator length has been reduced to 52.5 feet. This includes stages 1-5 and the wrist.

Other changes from the preliminary design include the reduction of segments in stages 1-3. Previously these stages had 3 segments, but to reduce complexity of the initial stages this was changed to one segment for each stage. They are connected through a hinge. No loss to the functional requirements has occurred due to this change.

A change to the wrist design has also been done. Actuation of the wrist will be accomplished through electrical motors mounted on the manipulator system. This change was incorporated to reduce the weight of the system and increase the reliability and response time of the wrist.

The azimuth drive used for the rotation of the EMMA™ system will reflect a +/- 180 design that will incorporate a simple hard stop. This will reduce wear to the umbilical system, reduce space needed to store umbilical slack, and increase total reliability of the system.

The dexterity of stage 4 has been reduced to eliminate weight and structural forces that will get exerted on the system. This change will not impact any of the functions that EMMA™ will perform.

The LOS and controls cabinet has been moved as an external unit that mounts to the sidewall of the tower. This design reduces the size of the airlock, allows easier access for the power and signal distribution, and decreases the footprint of the system.

1.3 Design Criteria

The EMMA™ system has been under development since 1995, and has evolved to provide teleoperated functionality in hazardous and radioactive environments similar to the operating environment anticipated in the Fernald Environmental Management Plant (FEMP) silos. The existing EMMA™ design is being modified to meet the Functional Requirements as set forth by Fluor Fernald (FF). This design will meet DOE and Fernald site design, safety, and performance requirements. This design will also meet additional applicable industry design standards and requirements. Table 1-1 identifies the FF Functional Requirements (*Technical Requirements Document, Silos 1 and 2 AWR Project*, C. No. FSC 624, TRD-40710-RP-001, Tables 2-2 and 2-11) that pertain to the manipulator system.

Table 1-1. The EMMA™ Manipulator System is Designed to Meet FDF Functional Requirements.

Requirement No.	Requirement / Method of Accomplishment

Requirement No.	Requirement / Method of Accomplishment
SWRS-001	**Ensure that the retrieval system does not compromise the integrity of the silos.** The EMMA™ manipulator system has been designed to ensure that the silo integrity Is not compromised in three ways. First, the EMMA™ manipulator system is contained within the 90' tower structure, and will be mounted directly to the Silo Bridge Platform. Second, a guide bearing will be installed at the base of the tower to prevent the manipulator from contacting the silo dome during insertion, extraction, or operation. Third, in silo operations with the manipulator are monitored by the operators through the camera trees located throughout the silo. Fourth, the manipulator will have configuration limits based on position sensors that are controlled through the monitoring control system to ensure the silo structure is not impacted. Lastly the flexible end stages of the manipulator will dampen out the forces transmitted to objects that are contacted.
SWRS-008	**Provide local control of all functions of the SWRS.** A local operating station (LOS) will be provided outside the tower to offer local control of all manipulator system functions (see Section 6.0).
SWRS-009	**Provide remote monitoring and control from the accelerated retrieval control room for SWRS process control functions.** A remote operating station (ROS) will be provided in the operator's trailer located in a safe work zone as determined by ALARA considerations. This station will allow control of all manipulator functions (see Section 6.0).
SWRS-010	**Restrict the placement of loads on the domes of the silos so that no live load greater than 700 lbs and/or three persons is upon the dome and/or the protective plywood and steel frame protective dome covers.** See response to SWRS-001. No loads will be placed upon the silo domes.
SWRS-011	**Restrict load geometries so that the load applied to a silo dome is distributed over a maximum area (i.e., limit geometry for equipment loading to a circular area at least 3 feet in diameter). Point loading is not allowed.** See response to SWRS-001.
SWRS-012	**Measure (or estimate by calculation) any load to be placed on a silo dome surface prior to activities on a silo dome.** See response to SWRS-001.
SWRS-013	**Ensure that design of SWRS provides for ease of decontamination and demolition at the end of Stage 2 operation.** A protective sheath and/or shell will be installed over the functional manipulator and mast sections of the system. This will simplify decontamination and eliminate debris collection pockets. The silo spray ring provides the first level of system decontamination upon system extraction, and a hand-held decontamination spray wand will be provided in the tower and accessible through glove ports to ensure that decontamination has been performed to safe levels.

Requirement No.	Requirement / Method of Accomplishment
SWRS-014	**Ensure that the design life of the SWRS is 10 years.** Historical data, prototype testing, and dynamic modeling data are being developed, accumulated, and analyzed to ensure that a 10 year design life is achieved. Additionally, all commercially available equipment is being selected to fulfill this requirement.
SWRS-016	**Utilize remote retrieval operations to the extent practical to limit personnel activities in accordance with ALARA principles.** The ROS, located at a remote on-site location, ensures operator safety during system operations. To further ensure enforcement of ALARA, no operator(s) will be allowed in the tower while the manipulator is deployed except in the event of system failure or maintenance activities which might require the system to be deployed. These scenarios will be identified and proceduralized at a later date.
SWRS-018	**Ensure that the equipment placed inside the silos is retrievable from the silos for maintenance purposes.** The z-drive provides vertical control of the manipulator, and will enable the manipulator to be completely retracted from the silo for maintenance and demobilization activities.
CS-001	**Provide a centralized control area. 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.** The SWRS offers both remote and local (ROS and LOS) operating stations.
CS-002	**Worker and operator exposures will be ALARA by performing normal process monitoring and control remotely.** All nominal system operations can be performed and managed from the ROS.
CS-003	**At the centralized control area, the distributed microprocessor based control system (DMCS) redundant human machine interface (HMI) shall provide control, monitoring, alarms, trending, archiving and printing of system operations.** The ROS is equipped with monitoring and control equipment including an HMI PLC PC, HMI Programming PC, CD read/write drive, and a printer. This system offers sufficient redundancy, and is capable of receiving/providing the input/output necessary for control, monitoring, alarm and warning indication, trending, archiving, and printing.
CS-004	**The DMCS configuration software will perform process control functions, interlock and logic routines, and sequential operations. A separate DMCS configuration software programmer station will be provided. Activation and deactivation of HMI screens, logic, and alarms will be easily performed.** The HMI PLC PC performs process control functions, interlock and logic routines, and sequential operations capabilities. A separate programming PC will be provided for programming functions. Both stations will be designed to easily activate and deactivate HMI screens, logic, and alarm controls.

Requirement No.	Requirement / Method of Accomplishment
CS-005	**DMCS real-time functions (e.g., data acquisition, data storage, display, and alarms) will be designed for 99% availability. Provide on-line diagnostics.** The PLC real-time functions have been designed to provide 99 percent availability through redundant and modular electronic systems. They are capable of providing on-line diagnostics.
CS-006	**Data handling functions (e.g., data entry, reporting, and archiving) at the HMI operator interface will be designed for 99% availability.** See response to CS-005.
CS-007	**Include down-time for lightning strikes, system maintenance, and off-line diagnostics in the system availability calculations.** The downtime required for these and other system events was considered in the FMEA and RAM analyses.
CS-008	**No single point failure will cause loss of the entire system.** Due to the system redundancy and modularity of the manipulator control system, no single point failure will cause loss of the entire system. For example if the ROS fails, the LOS will still operate.
CS-009	**Data stored at local microprocessors will be recoverable upon system restart. The microprocessors will have execution speeds, scan rates, and transmission rates selected for proper DMCS and process operation.** Data stored on the HMI PLC and PC will be backed up. The HMI PLC PC selection is based on a need for rapid and complete recovery upon restart, high execution speeds, scan rates, and transmission rates required for the SWRS operations.
CS-013	**Packaged control and monitoring systems will provide necessary monitoring and control interfaces with the DMCS; including operation trouble alarms, visual, and audible.** Both the LOS and ROS will display alarms and warnings through the HMI PLC PC operator and control panels. Trouble alarms will be displayed visually and broadcast audibly.
CS-019	**Commingling DMCS hardware with non-related systems in the control room will be avoided.** The manipulator's operating system is being designed as a stand-alone system that will prevent hardware commingling with non-related systems. The manipulator's operating system communicates with other AWR control systems, but does not offer integrated functionality with these systems. This is a safety measure to ensure that only one operator has control of the manipulator at any given time.
CS-020	**A segregated area in the control room for the DMCS with adequate workspace, document laydown space, traffic patterns, and maintenance access will be provided.** An area has been designated in the operator's trailer for the manipulator system ROS. The layout of this area will be designed in accordance with OSHA human factors considerations, and will provide sufficient workspace, document lay-down space, and traffic and maintenance areas.

Requirement No.	Requirement / Method of Accomplishment
CS-021	**DMCS operation, process, and alarm data will be stored long-term (archived). Large capacity storage media will be selected that will easily permit 30-day archival data retrieval.** The system will offer sufficient storage space for 30-days worth of data collection, at a minimum. The data will be transferred to a CD via a CD read/write drive, labeled, cataloged, and safely stored for data archiving purposes. The system, currently under development, will allow easy retrieval of archived data. Additionally, the data will be backed up at the end of each operating shift.
CS-022	**Ensure that computer hardware and software are year 2000 compliant.** All software and hardware was selected based on Y2K compliance.
CS-023	**The DMCS password and keylock security will prevent unauthorized use.** The PLCs will be programmed for password protection, and the CPUs will feature physical key lock security.
CS-024	**DMCS installed spare capacity of system hardware (i.e., input, output, memory) will be a minimum of 25%.** The HMI PLC PC and Programming PLC PC's will each provide a minimum of 25 percent spare capacity.
CS-025	**Selection of instruments will depend on range, accuracy, and compatibility with safety, reliability, and maintainability. Instrument signals will use standard voltage currents. Electronic instruments will be Factory Mutual approved or Underwriters Laboratories listed.** All components in the control system will be selected based on reliability, range, compatibility, safety, and maintainability. Additionally, the commercially available equipment selected to date offers UL listing, and all future equipment selection will be Factory Mutual approved or UL listed items.
CS-026	**The existing VITPP Uninterruptible Power Supply (UPS) will be used to power the DMCS.** All critical electronic equipment associated with the ROS will be powered from the AWR UPS system.
CS-029	**Instrumentation systems will be designed to provide remote sensing in inaccessible or high dose areas.** All manipulator instrumentation is being selected to offer high reliability in a radioactive and remote environment. Instrumentation will be designed with shielding, as required, to ensure availability and reliability requirements.

1.4 System Interface Points

The EMMA™ manipulator system, although an independent subsystem, has been designed to effectively interface with the bridge, utilities, end effector components, retrieval operation equipment, and control systems of the integrated AWR system. The design considers bridge interface with regard to weight, connection points, and forces exerted on the system in high winds, heavy snow, and other natural phenomena, and nominal and off-normal operating events. The utility requirements have been considered and connection points will be provided

3157

at the tower utility interface connections. The various equipment interfaces have been defined and are designed for ease of integration at the retrieval site. The operating stations, both local and remote, are designed for overall system compatibility. This feature offers increased spare capacity and operator cross-training potential. The table below outlines all of the EMMA™ subsystem interface points. An interface diagram (11GED080) is used to reference the interface number to a particular location in the system.

INFORMATION ONLY

3157

Table 1-2. The EMMA™ Manipulator System Interface List

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
GP-INT-001	TPG / GreyPilgrim	Control Trailer	Power to control equipment	Wire 12/3, specification	120 VAC, 20A Power, plugs, and sockets	At Fernald Site
GP-INT-002	TPG / GreyPilgrim	Control Trailer	Power to control equipment	Wire 12/3, specification	120 VAC / 20A	At Fernald Site
GP-INT-003	TPG / GreyPilgrim	Control Trailer	Power to control equipment	Wire 12/3, specification	120 VAC / 20A	At Fernald Site
GP-INT-004	TPG / GreyPilgrim	Control Trailer	Power to control equipment	Wire 12/3, specification	120 VAC / 20A with UPS	At Fernald Site
GP-INT-005	TPG / GreyPilgrim	Control Trailer	Power to control equipment	Wire 12/3, specification	120 VAC / 20A with UPS	At Fernald Site
GP-INT-006	TPG / GreyPilgrim	Control Trailer	I/O between GreyPilgrim and Providence Control	Wire 16/16, specification	Connection to I/0 module	At Fernald Site
GP-INT-007	TPG / GreyPilgrim	Control Trailer	Fiber optic cable	OLM module, cable ends, requirements	Supply fiber optic profibus communication cable from control trailer to the tower base	At Fernald Site
GP-INT-008	TPG / GreyPilgrim	Control Trailer	Control room space and equipment layout	Provide dimension of control room equipment, and layout of operator station	Provide necessary space and layout in overall control trailer design	At Fernald Site
GP-INT-009	Foster Wheeler / GreyPilgrim	Tower Base	Electrical cabinet on bridge	Provide control panel dimensions and location	Provide space for the location	At Fernald Site
GP-INT-010	Foster Wheeler/ GreyPilgrim	Tower Base	Power to EMMA	Provide wire and power requirements – 4/3, 120	Provide power, plugs, and receptacles	At Fernald Site

000520

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
			module	VAC / 100 A		
GP-INT-011	Foster Wheeler/ GreyPilgrim	Tower Base	Main high voltage power to EMMA module	4/4, 480 VAC, 100 A	Provide power, plugs, and receptacles	At Fernald Site
GP-INT-012	Foster Wheeler/ GreyPilgrim	Tower Base	Main 120VAC Power to EMMA module	12/3, 120 VAC / 20 A	Provide power, plugs, and receptacles	At Fernald Site
GP-INT-013	Foster Wheeler/ GreyPilgrim	Tower Base	Routing for electrical lines to our hydraulic pump	Provide wire and connectors, 480 VAC / 15 A for Hydraulic Pump	Space and routing path	At Fernald Site
GP-INT-014	Foster Wheeler / GreyPilgrim	Tower Base	Routing for electrical lines to our hydraulic pump	Provide wire and connectors, 480 VAC / 10 A for Hydraulic Pump heater	Space and routing path	At Fernald Site
GP-INT-015	Foster Wheeler / GreyPilgrim	Tower Base	Hydraulic pump placement	Provide dimensions, weight, mounting, and location requirements	Provide space and placement in overall bridge layout	At Fernald Site
GP-INT-016	Foster Wheeler / GreyPilgrim	Tower Base	Lightning protection	Provide wire specification for Lightning Protection, 1 wire 4/0 GND	Connector wire to overall grounding scheme at the tower base	At Fernald Site
GP-INT-017	Foster Wheeler / GreyPilgrim	Tower Base	Routing for hydraulic fluid line	Provide hydraulic hose pressure line and connectors	Space and routing path	At Fernald Site
GP-INT-018	Foster Wheeler / GreyPilgrim	Tower Base	Routing for hydraulic fluid line	Provide hydraulic hose return line and connectors	Space and routing path	At Fernald Site
GP-INT-019	Foster Wheeler/ Battelle / GreyPilgrim	Tower Base	3000 psi decon water	Rout cable from tower opening to the actuation package	Battelle/Foster Wheeler – Provide hose, connectors, sizes etc. Address freeze	Hose that is internal to the tower is installed at the tower/manipulator

INFORMATION ONLY

3157

000521

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
					protection	assembly site. Connection at the base of the tower will be performed at the Fernald site.
GP-INT-020	Providence/ GreyPilgrim	Bottom of Bridge	Spray Ring interface	Provide spool piece and bolts that will connect with the decon spray ring	Provide detailed specification of decon spray ring	At Fernald Site
GP-INT-021	Foster Wheeler/ GreyPilgrim	Bottom of Bridge	Silo riser interface	Provide spool piece and bolts that will connect with the silo riser piece	Provide detailed specification of silo riser piece	At Fernald Site
GP-INT-022	Foster Wheeler/ Battelle / GreyPilgrim	Tower Base	Pneumatic 125 psi	Route line from tower opening to the actuation package	Battelle/Foster Wheeler – Provide hose, connectors, sizes etc.	Hose that is internal to the tower is installed at the tower/manipulator assembly site. Connection at the base of the tower will be performed at the Fernald site.
GP-INT-023	Foster Wheeler / GreyPilgrim	Tower Base	HEPA filter and air duct	Provide hole, flange plate, and ducting inside of tower	Provide connection specifications, location requirements, HEPA filter, and any ducting outside of the tower	Ducting internal to the tower installed at the tower/manipulator assembly site. Connection to HEPA on bridge will be done at Fernald Site
GP-INT-024	Foster Wheeler / GreyPilgrim	Tower Base	Breathable air	Not in GreyPilgrim scope	Providing breathable air line	TBD
GP-INT-025	Battelle / GreyPilgrim	Tower Base – Tower Internal	Video line to tower camera	Route cable in the tower	Provide cable, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-026	Battelle / GreyPilgrim	Tower Internal	Tower camera mounting	Provide primary bracket for mounting of camera	Specific location, bracket details, and camera	Camera installed at Fernald Site, bracket will

INFORMATION ONLY

3157

000522

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
						be installed at the tower/manipulator assembly site.
GP-INT-027	Battelle / GreyPilgrim	Tower Base – Tower Internal	Video line to ADS	Route cable in the tower	Provide cable, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-028	Battelle / GreyPilgrim	Tower Internal	DAM 1 power line	Provide Power, Rout cables and specify required length	Provide cables and power requirements – 14/3 – 120 VAC / 20A	At the tower/manipulator assembly site.
GP-INT-029	Battelle / GreyPilgrim	Tower Internal	DAM 2 power line	Provide Power, Rout cables and specify required length	Provide cables and power requirements – 14/3 – 120 VAC / 20A	At the tower/manipulator assembly site.
GP-INT-030	Battelle / GreyPilgrim	Tower Internal	DAM 1 mounting	Mounting of DAM 1, Provide bracket	Provide DAM 1 and specifications	At the tower/manipulator assembly site.
GP-INT-031	Battelle / GreyPilgrim	Tower Internal	DAM 2 mounting	Mounting of DAM 2, Provide bracket	Provide DAM 1 and specifications	At the tower/manipulator assembly site.
GP-INT-032	Battelle/ GreyPilgrim	Tower Internal	Alarm mounting	TBD	Provide Alarm and specifications	At the tower/manipulator assembly site.
GP-INT-033	Battelle/ GreyPilgrim	Tower Internal	DAM 1 line to radiation detector 1	Provide routing ,length specification, and seal tight conduit along floor	Provide cable, connector, specifications	At the tower/manipulator assembly site.
GP-INT-034	Battelle/ GreyPilgrim	Tower Internal	DAM 1 line to radiation detector 2	Provide routing ,length specification, and seal tight conduit along floor	Provide cable, connector, specifications	At the tower/manipulator assembly site.
GP-INT-035	Battelle/ GreyPilgrim	Tower Internal	DAM 2 line to radiation detector 3	Provide routing ,length specification, and seal tight conduit along floor	Provide cable, connector, specifications	At the tower/manipulator assembly site.
GP-INT-036	Battelle/ GreyPilgrim	Tower Internal	DAM 2 line to radiation detector 4	Provide routing ,length specification, and seal tight conduit along floor	Provide cable, connector, specifications	At the tower/manipulator assembly site.
GP-INT-037	Foster Wheeler/ Battelle / GreyPilgrim	Tower Internal / Bridge	Radiation detector 1	Provide location and layout of radiation detector	Battelle – Provide sensors, specifications, mounting plan Foster Wheeler –	At the tower/manipulator assembly site.

INFORMATION ONLY

3157

000523

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
					mounting interface on shielding plate of bridge	
GP-INT-038	Foster Wheeler/ Battelle / GreyPilgrim	Tower Internal / Bridge	Radiation detector 2	Provide location and layout of radiation detector	Battelle – Provide sensors, specifications, mounting plan Foster Wheeler – mounting interface on shielding plate of bridge	At the tower/manipulator assembly site.
GP-INT-039	Foster Wheeler/ Battelle / GreyPilgrim	Tower Internal / Bridge	Radiation detector 3	Provide location and layout of radiation detector	Battelle – Provide sensors, specifications, mounting plan Foster Wheeler – mounting interface on shielding plate of bridge	At the tower/manipulator assembly site.
GP-INT-040	Foster Wheeler/ Battelle / GreyPilgrim	Tower Internal / Bridge	Radiation detector 4	Provide location and layout of radiation detector	Battelle – Provide sensors, specifications, mounting plan Foster Wheeler – mounting interface on shielding plate of bridge	At the tower/manipulator assembly site.
GP-INT-041	Providence / GreyPilgrim	Tower Internal	Umbilical management winch	Location of winch and routing of cable	Provide winch, specifications, relays,	At the tower/manipulator assembly site
GP-INT-042	Providence / GreyPilgrim	Tower Internal	Power for winch	GreyPilgrim, Inc. supply power, TBD	Provide requirements, connectors and cable	At the tower/manipulator assembly site
GP-INT-043	Providence / GreyPilgrim	Tower Internal	Control for winch	Use relay to connect into GreyPilgrim, Inc. PLC and network system	Signal Requirements, Interface with 8 I/O at control trailer	At the tower/manipulator assembly site.
GP-INT-044	Battelle / GreyPilgrim	Actuation Package	GEE/ADS control panel	Provide space and mounting locations, overall layout	Provide control panel, specifications	At the tower/manipulator assembly site.
GP-INT-045	Battelle / GreyPilgrim	EMMA	GEE control line 1	Provide routing of control cable 1 cable, length specification	Provide cable/line, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-046	Battelle / GreyPilgrim	EMMA	GEE control	Provide routing of	Provide cable/line,	At the tower/manipulator

INFORMATION ONLY

3157

000524

Interface number	Interface Team member	Location	Description	GreyPilgrim Responsibility	Team Member Interface Responsibility	Time of connection or Installation
			line 2	control cable 2, length specification	connectors, and specifications	assembly site.
GP-INT-047	Battelle / GreyPilgrim	EMMA	Camera control line	Provide routing of camera control cable, length specification	Provide cable/line, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-048	Battelle / GreyPilgrim	EMMA	Pneumatic line	Provide routing of 125 psi air line, length specification	Provide cable/line, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-049	Battelle / GreyPilgrim	EMMA	Decon water line 1	Provide routing of 3000 psi decon water line 1, length specification	Provide cable/line, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-050	Battelle / GreyPilgrim	EMMA	Decon water line 2	Provide routing of 3000 psi decon water line 1, length specification	Provide cable/line, connectors, and specifications	At the tower/manipulator assembly site.
GP-INT-051	Battelle / GreyPilgrim, Inc	EMMA	GEE mounting interface plate	Provide mounting plate	Provide wrist, specifications, and mounting plate that will interface with stage 5 of the EMMA manipulator	At the tower/manipulator assembly site.
GP-INT-052	Battelle / Providence, GreyPilgrim, Inc	Tower Base, Tower Internal	Fiber optic line	Provide interface through tower for fiber optic line, rout cable through tower	Battelle – provide fiber optic requirements, and provide cable and connectors for routing through the tower Providence – provide fiber optic line and connector to the tower base	Cable that is internal to the tower is installed at the tower/manipulator assembly site. Connection at the base of the tower will be performed at the Fernald site.
GP-INT-053	Foster Wheeler / GreyPilgrim	Tower base	Secondary Spray Wand	Provide an inlet port and viewing window for spray down	Provide quick connect attachment of water hose on bridge and the spray wand	At Fernald Site
GP-INT-054	Foster Wheeler / GreyPilgrim	Tower Base	Attachment of Tower to the Bridge	Provide bolt pattern, bolts, and template	Provide structure on bridge to interface with bolt pattern	At Fernald Site

INFORMATION ONLY

000525

3157

Document and Submittal Summary

The EMMA™ manipulator system is comprised of five discrete subsystems: 1) deployment tower system; 2) actuation package; 3) mast; 4) manipulator; and 5) instrumentation and controls system. Detailed descriptions of these subsystems including system interface points, physical characteristics, materials of construction, and design assumptions are provided in the following sections of this document. Additional supporting information pertaining to the system design is included in the system specification. It is our assumption that this information best represents the final design of the system

2.0 DEPLOYMENT TOWER SYSTEM

The primary purposes of the deployment tower are to provide containment for the EMMA™ manipulator and its support systems during transport, maintenance, and system shutdown, house the mechanical operating systems (azimuth and z-drives) which provide gross positioning of the manipulator, and provide a maintenance and local operating control station area. The deployment tower is also designed to provide a redundant containment system in the unlikely event of a Radon Control System (RCS) failure. This made for a design of the tower that is airtight, maintains an airlock, and contains sealed connections. The mounting of the control and power distribution cabinet, as well as the hydraulic pump unit, is done at the tower base. These are connected after the erection of the tower.

The deployment tower structure is a large cylindrical tower made of A36 carbon steel with an airlock room attached internally at the base. The cylindrical structure is a 90-foot tall shell with a wall thickness of 5/16" for the lower 20 feet and ¼" for the remaining 70 feet. The tower shell provides the structural support and is constructed to provide secondary shielding and containment. It is composed of two sections to allow for the insertion of the manipulator and is attached together with an 80-bolt flange connection at the midpoint. Buckling concerns associated with a structure of this magnitude have been addressed through bracing, achieved through ovalling rings placed at 11.25-foot intervals throughout the tower structure. Each ovalling ring has a 12' inner diameter and a 13' outer diameter. The disc-shaped ovalling ring is then welded to the outside of the tower at designated points in accordance with AWS welding standards. The ovalling rings maintain the circular profile of the structure and prevent shell buckling. GreyPilgrim has performed the critical calculations, which are moment load, weight, height, and the center of gravity. Two lifting points are provided, one with a tailing lug at the base and the other 60 feet from the base with a trunion.

The tower is designed in accordance with the ASCE 7-98 (a more recent version of ASCE 7-95). The tower wind loading calculations were prepared under type b and c scenarios ("b" is rural exposure and "c" is urban exposure). These calculations are provided in Appendix B and contain supporting data including the technical report on wind loading scenarios and the dynamic modeling program used to develop the wind loading data. Scenario "c" has been selected as the design basis. The results of these calculations indicate a maximum wind shear and overturning moment at the base of the tower at 17.99 Kips and 897.9 Kip feet, respectively. The dead load moment from the EMMA™ system is 140 Kip feet, which adds to the 897.9 Kip feet of the overturning moment due to wind loading.

The calculation for the seismic loading were determined to be worst case for the structure. These were performed with FDF-TRD appendix C requirements and the UCRL-15910 for earthquake loading. The seismic loads were determined to be 28.77 Kips from shear loading and a 1925.33 Kip-ft overturning moment at the tower base. The structure and bolting interface have all been designed to withstand this loading with factors of safety.

The tower will attach to the bridge using eight separate bolt patterns equally spaced around a 12'-4.5" circle at the base of the tower. The base chair of the tower consists of two rings around the circumference of the tower. Holes are drilled through both of the rings for 16 1-3/8" A588 grade 50 bolts. The bolts serve as the structural connection to the bridge.

The deployment tower structure and anchor bolts have been rated a SSC, PG 3 based on the safety concerns identified with the structure. This structure represents the worst possible case scenario as related to catastrophic failure. As a result of this critical PG rating, the design is being developed under close scrutiny and with attention to codes and standards that will mitigate potential failure. Applicable codes and standards for design and construction incorporation include the American Institute of Steel Construction Standards and Codes (AISC), the American Welding Society Standards (AWS D1.1), and the American Society of Mechanical Engineers Standards for steel stacks (ASME/ANSI STS-1, Current 1999 edition). The four key areas of risk associated with this structure and the risk mitigation approaches to each of these risk areas are provided in
Table 3-1.

Table 3-1. Risk Mitigation Plan for SSC PG 3, EMMA™ Tower Deployment Structure.

Key Risk Areas	Design/Construct Criteria	Action
Shell Buckling	Shell buckling is mitigated by maintaining peak compressive stresses in the shell within buckling allowables as permitted by the ASME.	The EMMA™ tower structure as designed, results in peak compressive stresses of less than one-third to one-half of the allowable stresses. This is achieved through maintaining a minimum wall thickness of ¼" steel to ensure constructability and safe transport of the 12-foot diameter tower.
Failure in Tension (including weld failure)	Mitigate weld failures by application of the more stringent AWS requirements for dynamically loaded structures (e.g., bridge).	Tensile stresses assessed in the tower design are only 1/4 to 1/3 of the allowable tensile values. Measures will be taken in the equipment specification and further in the application of QA/QC to ensure that 90 percent penetration is achieved on all welds. Additionally, 100 percent testing of all circumferential butt welds to the AWS dynamic test levels by ASNT TC-1A Certified, Level 2 Inspectors will be required.
Failure by Fatigue	Mitigate failure by fatigue by maintaining shell stresses well below the endurance limit of the	Critical connections, including bridge tower interface connections, openings in the shell

3157

Key Risk Areas	Design/Construct Criteria	Action
	ASTM A36 mild carbon steel material used in construction.	and structural reinforcement and tower attachment designs were developed based on state-of-the-art methods of analysis. One scenario includes wind gust buffeting and vortex shedding. The data was integrated into the final design and will be developed to provide detailed requirements for eliminating notches and stress raisers.
Brittle Fracture	Mitigate brittle fracture failures by ensuring that stack plate materials selected for tower construction meet fracture toughness standards set forth in the ASTM for the site environment conditions.	Identify A-36 carbon steel or a more fine-grained steel for tower construction. Require ultrasonic testing for 100 percent of the stack plate material to ensure that any inclusions are within the limits set forth by the ASTM.

The deployment tower houses the z-drive, azimuth drive, actuation package, mast, flooring structure, local operating station, and the EMMA™ manipulator. This system weighs approximately 88,500 lbs., and when attached to the silo bridge platform, will impart no load to the silos. The EMMA™ is attached to the mast, which is rigidly mounted to the inner frame of the actuation package. All of these components are discussed in the following sections.

Tower Base

The base chair of the tower consists of two rings around the circumference of the tower. These rings are separated by three stiffeners in 8 equally spaced locations around the perimeter of the tower. Holes are drilled through both of the rings for 16 1-3/8" A588 grade 50 bolts. The bolts serve as the structural connection to the bridge.

The tower floor consists of a central ring and 8 radial I-beams. The central ring is for the support of the guide bearing assembly while the I-beams take the horizontal load imparted to the guide bearing by the manipulator. The floor will have removable plating except under the airlock. The removable plating will rest on the I-beams as well as a rolled angle around the interior of the structure. The central ring is offset one foot from the center of the tower to provide more space for maintenance.

Radiation detectors are located beneath the floor plating and behind the guide bearing ring.

To maintain constant 250 cfm airflow in the tower structure, a circular piece of rubber with radial slits will be placed below the guide bearing. The rubber resists tearing, but is flexible enough to allow the arm to pass though with minimal resistance.

2.2 Z-Drive

The z-drive is contained within the tower structure and connects to the actuation package. The z-drive controls the vertical position of the mast, actuation package, and arm and translates the entire actuation package in the vertical direction. It provides for vertical motion of the

manipulator up to 70 feet. This motion is driven by a high strength winch system. The winch system's wire cable is routed from the winch located at the top of the tower, through pulleys on the edges of the actuation package and the side of the tower, and then back to a hard connection at the top of the tower. This gives the winch a mechanical advantage of 4 and adds to the stability to the system, while allowing the top of the actuation package to remain open for actuator maintenance. This system will have several safety features to ensure correct operation, such as various alarms located in the winch. The control of the winch system's motor will be done through a variable frequency drive. This device will provide various warnings including an off-normal indicator. Additional sensor devices will be used to ensure that the z-position of the actuation package is known and that mechanical or rigging failures can be detected in the system. This system is designed using a ½ HP drive motor that can support a load of 31,000 lbs. using the z-drive system.

2.3 Guide Rail and Guide Bearing Assembly

Four guide rails in the tower are used to keep the actuation package from swaying and to brace the package during azimuth drive operation (the actuation package is discussed in detail in Section 3.0). The guide rails extend the length of the tower and provide lateral and secondary vertical support for the actuation package. The guide rails and guide shoes are commercially available equipment being supplied by a certified commercial elevator companies. The rail supports are 3-inch diameter tubes welded to a T-beam and plate. At each attachment point guide rails are shimmed to allow for fine adjustment during tower erection. The guide bearing is mounted to the floor of the tower. The combination of this bearing and the lateral bracing of the guide rails support the moment generated by the weight of the manipulator when it is flexing. The expected maximum load on the bearings is taken from the moment generated on the mast when the manipulator is extended to maximum reach.

The bearing ring housing is composed of two large assemblies, the bearing ring assembly and the housing race. The bearing ring assembly consists of eight identical roller assemblies that form a circular shape. The housing race is a 6 piece assembly that is mounted to the floor of the deployment tower. Loads exerted by EMMA™ are supported by the bearing ring assembly and the actuation guide rails. The bearing ring assembly then transfers the load to the housing race, which ultimately transfers the load to the base of the tower. This prevents direct contact between the manipulator and silo and eliminates loading on the silo structure.

The guide bearing and housing race assemblies serve several purposes. Its most important function is to provide smooth entrance into the silo and prevent contact with the 36" silo opening. This is provided by the large rollers positioned in the x-y plane of the housing. As the manipulator moves up and down (along the z-axis), the rollers bear any side loads that the arm may create.

When the manipulator is fully deployed inside the silo and extended to reach the far working areas in the silo, the rollers and the actuation guide rails counter the moment associated with this extension.

These stacked bearings transfer the radial load to the housing race while giving the entire assembly the freedom of rotational and vertical movement.

3157

The weight of the bearing ring assembly is transmitted to the housing race via 16, stud-type bearings that are threaded into each bracket assembly. This housing race interfaces with the tower base and is connected through 8 bolts in a radial pattern.

2.4 Maintenance Crane

The maintenance crane is used for vertical lift of the actuators into the actuation package during maintenance and replacement. The maintenance crane lifts the actuators from the bottom of the tower and places them in the actuation package during installation and maintenance operations. The maintenance crane is located at one side of the top of the tower. The crane consists of a rotary motor, spool, trolley, and a length of wire cable. The maintenance crane is a standard hoist that runs along an I-beam. The motor drives the spool that controls the wire cable, and trolley connecting the crane to the I-beam allows the horizontal position of the cable to be changed. The trolley runs along a guide that passes over the actuation package. The linear positioning of the trolley and the rotational control of the azimuth drive allows for access to all actuators located in the actuation package. This crane can support a load of approximately 1000 lbs.

RCS requirements

Achieving the necessary airflow in the deployment tower is accomplished by running an air duct into an opening in the tower , which then travels to the top of the deployment tower. This duct is installed during fabrication and tied down to the guide rails. The RCS system requires that the tower is under negative pressure and has a continous airflow through the entire tower and into the silo inlet port. This is achieved with the HEPA filter location and airduct routing.

2.6 Airlock

The airlock is incorporated into the tower structure. This airlock can be used for access of all personnel and most replacement equipment. The airlock is framed by 2x2x3/16 angles with a ¼" floor and 1/8" wall plate. It is positioned in such a way that it does not interfere with the guide rail supports. The outer door mounts to a flange welded to the outside of the tower while the inner door mounts to the airlock wall. The second door is a plastic curtain to ensure adequate airflow. The airlock will have to be seal to hold a 0.1" water gauge pressure differential to the external environment.

2.7 Maintenance Floors

Four (4) maintenance floors have been integrated into the tower structure design. These floors will enable maintenance activities and visual observation at all points of the manipulator when it is extracted from the silo. The maintenance floors are positioned directly above the airlock. The first floor is located ten feet off the floor of the tower. The first floor is accessed by a ladder running up the side of the airlock, while another ladder begins at this platform. From this platform the other ladder runs the remaining height of the tower, passing through hatches in each maintenance floor encountered. This larger ladder has a safety climb to comply with OSHA regulations. Approximately 5 feet below the roof of the tower is a platform for supporting and maintaining the z-drive winch.

Each of the first three maintenance floors is equipped with a fold-down section to allow close, safe access to the arm. The fold down sections have a circular notch cut into them to fit around

the arm. Handrails cordon off all edges of the maintenance floors to address worker fall protection requirements. The fold down sections are raised and lowered using a hand winch attached to the wall of the tower. This system allows the actuation drum to travel through sections of the tower where maintenance floors are located. When the floors are in use, an operator can stand on the permanent section of the floor and use a winch to lower the remaining portion of the floor. In the deployed position, the floor rests on metal bearings on the tower wall to provide support. The operator will use the winch to stow the floor when it is no longer in use. The permanent portion of the floor on the side of the actuation package offers more room because of the offset, and has an opening to provide sufficient clearance for a ladder and operator to pass through.

2.8 Utility Connections

All utilities required for system operation will be hardwired into the tower control panel with the exception of service loops to the actuation package. The utilities will breach the tower wall at the utility access port and then immediately placed in cable tray for a 90 degree bend around the inside of the tower. Once there they will turn up the wall secured in place by unistrut, an industry standard modular connection system welded every ten feet up the tower wall. The opening in the tower will be sealed with hardenable seal that will fit around the various utilities and equipment umbillicals that are located in the tower.

2.9 Lighting

Interior tower lighting will be provided to adequately illuminate all arm operations within the tower including maintenance activities. These lights have been located. Emergency lights exist along with exit sign to mark exit routes in the event of an emergency.

Painting

The interior and exterior exposed carbon steel surfaces will be painted.

Spool Piece

The spool piece is a flexible, airtight tube that connects the bottom of the spray ring to the top of the silo in the Fernald Silos 1, 2 & 4 project. The spool piece drains the spray ring into the silo. The spool piece is also required to absorb 3-4 inches of deflection in the bridge structure that the spray ring is mounted to.

A rolled flange on the bottom of the spray ring, and a flanged riser at the top of the silo dome provide the attachment points for the spool piece. The distance between the spray ring and the riser is 68" for Silos 1&2 and 73.75" for Silo 4. The silo domes can withstand no more than 700-lbs. load.

A rolled flange welded to a long metal tube is bolted to the flange at the bottom of the spray ring. A second rolled flange welded to a 6" metal tube is bolted to the riser flange on top of the silo dome. The gap between the tubes is encased in a flexible neoprene boot, clamped at each end to the metal tubes. Large hose clamps as specified in the Providence Group's slurry pump design are used to attach the boot.

For Silos 1&2 the long metal tube (Middle Tube Weldment) is 5.5" shorter than the tube for Silo 4 because the Silo 4 is a different sized dome.

A flexible PVC skirt is cement bonded to the inside of the long metal tube to deliver the waste directly into the silo riser. When the bridge structure is in the un-deflected state, the skirt terminates 1" below the opening in the silo riser.

3157

3.0 ACTUATION PACKAGE

The actuation package is constructed of the same carbon steel box tubing as the mast. The actuation package's primary purpose is to house the hydraulic actuators and route the cables to their appropriate positions for manipulator segment attachment. The actuation package is divided into two sections, the inner frame and the outer frame. The inner frame rotates inside of the outer frame as it is driven by the azimuth drive.

3.1 Outer Frame

The outer frame of the actuation Package interfaces with the inner frame, the z-drive and the guide rails. The horizontal load is transferred to the guide rails through the interface with the inner frame and the guide shoes mounted on the outer frame. The interface with the inner frame is a piece of rolled metal, which rotates on wheels mounted to the outer frame. The load of the inner frame and manipulator is supported through a large chain and roller bearing connection. This type of design elminates any loads other then the verticial load of the system to be exerted. Loading the outer frame in such a manner allows for the azimuth drive to work effectively and improved reliabilty of the design.

The outer frame is constructed of standard channels and I-beams. It consists of a main I-beam that transfers the weight load from the inner frame to the outer frame. The two snatch blocks for the z-drive are mounted along this main beam. Under the main beam is a structure that allows access to at least three main actuators at a time for replacement. Extending down at four places are supports for the wheels that bear to the rolled steel ring. A support structure for the azimuth drive and the umbilical routing is located on the one side of the frame.

3.2 Inner Frame

The inner frame of the actuation package contains the arm control system (ACS), the hydraulic actuators, all the manipulator's electronic and hydraulic systems, and the azimuth. Additionally, connections and space will be provided for the modular GEES and ADSS power and control systems. The inner frame of the actuation package is designed around a backbone of six high-force hydraulic actuators. These six actuators are placed in a line down the center of the actuation package and are responsible for bending the first three stages of the manipulator.

Each of these actuators is housed in a self-supporting frame. Each actuator frame contains a sealed enclosure around the cylinder and a metal frame around the travel space of the rod. The sealed enclosures act in conjunction with the secondary glands to provide redundant sealing and cylinder leak prevention. The metal frame around the rod is designed to bear the entire compressive force of the actuators. The metal frame bolts to a flange plate, which in turn bolts to the actuator. Inside each metal frame, a metal block, or keyed plate, is attached to the end of the rod along with the load cell. This keyed plate contains machined holes that enable the cables to be passed through for connection to the corresponding manipulator. Because these actuators are used for 1 DOF joints, the extension of the right and left cables are identical which eliminates the need for a snatch block. The cables are fixed in-place, using bolts on the threaded fittings for easy cable length adjustment. Once the cables and load cell are attached,

a keyed plate is bolted to the metal frame at the open end. The cables are passed through a bushing that has a properly radiused wall for cable routing.

Each of the six high force actuator frames (constructed to withstand up to 120,000 lbs. of force) will slide into place in the actuation package.

The actuation package contains six additional actuators used to control cables encased in conduit. The conduit-encased cables control stages 4 and 5 of the manipulator. The cables activated by the six high-pressure actuators, described above, control stages 1 through 3. The cables for stages 1 through 3 are not encased in conduit.

Support equipment such as hydraulic valves, gripper control equipment, and arm control PLC, I/O modules are all located in the inner frame. This equipment is accessible because the actuation package can align with a maintenance floor in the tower. Its open structure allows for easy access to equipment. A floor structure has been included into the package so that personnel can work with equipment throughout the 8-foot diameter package. The package is locked down during these activities so that the system is directly attached to the tower structure and not capable of vertical movement.

3.3 Azimuth Drive

As stated previously in Section 2.0, the azimuth drive is mounted to the lower portion of the actuation package and rotates the inner frame of the actuation package in a +/-180 degree sweep configuration. This is done so that a simple hard stop can be installed that will protect against damage to retrieval equipment and umbilical. This rotation feature provides angular positioning of the manipulator while inside the silo.

Extending down at four places are supports for the wheels that bear to the rolled steel ring. A support structure for the azimuth drive and the umbilical routing is located on the one side of the azimuth drive output interfaces this bearing ring using a cable rotation system. The drive in combination with cable tensioners controls the cable motion. The cable is attached to the inner frame bearing ring. Bearings attached to the outer frame of the actuation package support the inner drum and allow it to rotate freely. The inner drum houses the hydraulic rams, hydraulic valves, the wrist drive system, the cable routing system, and the mast interface.

Braking System

Braking used in the z-drive system is done through the z-drive actuation that has controlled acceleration and deceleration. This is the primary braking or stopping method for the system.

A hardstop can be built in to provide a rigid connection to the tower structure. This would prevent any vertical motions and creates a direct attachment of the actuation package to the tower structure. Under these conditions the actuation package is no longer an overhanging load.

4.0 MAST

The primary function of the mast is to provide rigid support when supporting the EMMA™ manipulator as it is deployed into the silo, and during in-silo operations. The mast is 13-feet long, weighs approximately 2000 lbs., and can be accommodated by a 30-inch diameter opening. In addition to supporting the manipulator, the mast also routes the manipulator cables that are fed through the actuation package, and provides a bearing surface against the guide bearing during full insertion of the manipulator.

The primary structure of the mast is coposed of two A36 steel T-beams, (I-beams with one flange removed) and a ¾ " thick rolled plate. The T-beams are welded to interface plates that facilitate the connections to the manipulator and the actuation package. The aluminium plate is attached to the T-beams and the interface plates with a series of brackets and bolted connections. The aluminium plate has an outer radius of 15" and is designed to bend the load imparted by the guide bearing.

The structure allows room for the cables, conduit, and umbillicals that travel through the mast to the arm. Removable bushings route cables to the appropriate locations at the mast and manipulator interfaces. A sheath will be connected around the mast.

3157

EMMA™ MANIPULATOR

EMMA™ is a 52.5-foot long, 30-inch diameter, cylindrical serpentine manipulator composed of five independent stages and a wrist. Stages 1 through 3 are single degree of freedom (1 DOF) stages, capable of bending only in a vertical direction. Stages 4 and 5 are two degrees of freedom (2 DOF) stages, and provide pitch and yaw capability, which allows the stages to bend both in vertical and horizontal configurations. The 2 DOF wrist at the end of the manipulator provides local dexterity for gripper, end effector, and other special tooling used for silo waste retrieval activities. The equipment is designed so that the wrist, stage 4, and stage 5 provide the fine positioning of the end. Prior stages and actuation package motion is for the gross positioning of the manipulator. The wrist and five stages of the manipulator are expected to weigh approximately 5000 lbs.

The manipulator is designed to operate under the following parameters:

Operate reliably for 1,000 hours (no scheduled maintenance activities)
Able to reach the sluicing pump silo when the headroom has reached a height of 23 feet
Perform waste retrieval activities in operating temperature ranges of 32°F to 100°F with a humidity range of 10-100% humidity
Manage, as a minimum, a 200 lb. payload (includes GEES and ADSS weight)
Provide ability to reach all points on the silo walls and the silo floor.
Capable of remaining in the silo between operating shifts to minimize insertion/retraction times and maximize in-silo operating periods

This system, when combined with the z- and azimuth-drives located in the deployment tower, results in a manipulator with sufficient dexterity and lifting capability to carry out operations required for successful mission completion.

The manipulator's mechanical behavior is based on the actuation of stages (all stages are controlled with steel cables and connected via termination segments; the bending moment is transmitted from segment to segment via elastomeric couplings. There are 5 stages in the manipulator. Stages 1-3 are constructed from a single segment. Stages 4 and 5 are constructed from 3 segments.

The drive cables for stages 4 and 5 are isolated from the previous stages by conduit, thus actuating these stages does not affect the previous stages other than changing the transmitted movement due to gravity.

The drive cables for stages 1, 2, and 3 are not housed in conduit, so the forces applied to one stage are transmitted back to the previous stages. This reduces the overall cable tensions required to lift the manipulator, but also requires the use of back tension to prevent undesired motion of previous stages. This means that an additional cable is run opposite to the main cables to provide the control of the position of all of the stages despite the fact that they are coupled.

Manipulator Segment Components—The segments contain cable routing bushings, cable mounting fittings, and connection fittings. The cable routing bushings are constructed of hardened steel to reduce wear on the bushing surfaces as the actuation cable passes through the bushing.

The cable terminatio fittings provide ease of assembly and maintenance. These fittings are affixed to the exterior of the segments, and allow easy cable removal and insertion. These fittings transfer the load from the cables to the structural components of the segments. The connection fittings enable the transfer of both compression and torsion. In stages 1, 2, and 3, segment structure is designed to take these loads through separate load paths.

5.1 Stages 1 through 3

The first three stages of the manipulator provide the basic positioning and major lifting capacity of the system. These stages are rather specialized in that they are designed only to provide motion in one direction (1 DOF). Stages 1, 2, and - 3 are 132 inches, and each weigh approximately 850 pounds.

Stage construction is accomplished through a thick curved backplate that provides support against the guide bearing and an aluminium honeycomb structure is resistant against the shear, compression, and torsional forces experienced in the segments. Plates at the end of the segments contain the bushings and hinges that are used to link stages, attach cables, and rout cables through the segments. Umbilicals, conduit, and cables for stages and end tooling located farther down the arm are routed through the sides of the segments. This area is accessible through hatches in the outer shell of the segments.

Stages 1, 2, and 3 use revolute joints that restrict movement to one degree of freedom. Each of these stages uses a rotational hinge joint. A hard stop will limit the rotation between an angle of 0 and 45 degrees with respect the to vertical axis. As a result, the stage can only bend in one direction and cannot reverse its direction of bend as is possible in the universal stages (stages 4 and 5). This significantly simplifies the kinematics of the system and allows for more accurate tracking of the position of the first three stages. This also allows for the addition of simple and robust encoders on the manipulator that will further increase the accuracy of the forward kinematics calculations.

No conduit is used in the first three stages, so cables actuating distal stages affect the dynamics of the preceding stages. Termination segments for proximal stages act as pass through segments for more distal stages. The result is that the more proximal cable sets do not need to pull with as much force because distal cable sets are supporting a significant amount of the weight of the manipulator. However, proximal cable sets will be sized to support the full weight of the system in the event of a cable failure.

5.2 Stages 4 and 5

While stages 1, 2, and 3 are intended to provide the basic positioning of the manipulator, stages 4 and 5 are designed for finer positioning of the end effector. These stages are intended to bend in all directions and are isolated from other stages through the use of conduit. Stages 4 and 5 of the arm use elastomer 2 DOF couplings to provide the bend in the stage. Unlike the joints in stages 1, 2, and 3, these couplings are free to bend in any direction. These

3157

stages rely on the flexing of elastomer cylinders to provide bending capabilities. The use of conduit effectively isolates the cables used to drive these stages from the motion of the previous stages. Stages 4 and 5 do not aid in the lifting of any of the other stages.

Each stage is designed to consist of three segments that act together when the stage is actuated. Like the first 3 stages, Stages 4 and 5 are also cable driven. However, in these stages the cables are carried in individual conduits up until termination. Employing the conduit de-couples the mechanical behavior of the stages from the first three stages and from each other, thus enabling independent actuation authority over either stage.

Stage 4 can bend to 90 degrees in the vertical direction and 45 degrees in the horizontal direction. This design minimizes torsional loading the the manipulators, but maintains the necessary dexiterity for operation.

Both stages 4 and 5 use 6 cables for actuation. The six cables for stage 4 are divided into 3 groups of 2. This provides a split in the load carried by a particular cable. A saftey factor of 3 is used on the cables so if one pair of cables were to break the other pairs can support the load transmitted. These two cables act together to deliver the desired motion authority. Due to the 3 cable actuation configuration pitch and yaw motion are coupled together. This means the part of the control system lower algorythims include a method for resolving this coupling.

Each group of cables pairs exits the conduit they are looped in a block and tackle system that amplifies the amount of force applied while reducing the travel. In stage 4 this amplification is 7:1 and the looping of cables is located into segment 3.

In stage 5 the amplification is 5:1 and the looping of cables is located in the third segment of stage 4.

5.3 Coupling Overview

The couplings are a significant component in the proper functioning of the EMMA™ manipulator. The resilience of these members ensures that the bend of a stage is spread out over several joints in a relatively equal manner. It allows for the inclusion of the flexible joint and a structural member. This specialized coupling is only included into the dexertous stages 4 and 5. Stages 1, 2, and 3 do not use any couplings and are connected by a hinge joint.

The coupling is a hollow elastomer cylinder bonded to steel end caps. As the coupling bends, the cylinder resists the bend and passes the moment back to the next proximal joint. Since the cylinder provides resistance in all directions, the joint can bend effectively in all directions.

Affixed to these joints is an external U-joint. This device takes the torsional, compressive, and shear loads exerted onto the joints, thus elminating these loads on the elastomer. This is necessary for a large manipulator where the torsional forces are high and would cause the manipulator to twist excessively.

Design parameters for the couplings are:

Function between 32°F and 100°F and are undamaged by external temperature variation between –25 F and 105 F.
Withstand the radiation in the silo. This is estimated to be 700mrad/hr.

3157

Function in a humid environment.
Each coupling must be able to bend to 30 degrees to achieve an overall stage bend of 90 degrees.
Meet the specific loading requirements of each joint of the manipulator

The couplings used in stages 4 and 5 are composed of hollow elastomer cylinders bonded to aluminium end caps. Chemlock 13 adhesive has been chosen for this application. The outer diameter is 8", with an inner diameter of 3", an elastomer length of approximately 6", and an overall length of 14.75". The end caps will mate with the segments and provide the stiffness and strength required for a bolted connection.

5.4 Wrist

The wrist sockets into the termination segment of stage 5). The cable assemblies are routed through the length of the manipulator and finally into the central segment member where they meet the main portion of the wrist. The wrist provides roll and pitch motion for the GEES.

A flexible protective covering (sheath) will surround the wrist and protect the gripper umbilical. Additionally, the umbilical section at the wrist will be fitted with quick disconnects for easy replacement.

The wrist is designed in accordance with the following design criteria:

Maneuver, at a minimum, a 200 lb. payload
Provide roll motion of up to ±180°
Provide pitch motion of up to ±60°
Withstand the radiation and humidity expected in the silo environment
Withstand operations in temperature ranges of 0°F to 110°F

The wrist design will include two electrical motors that use a gearbox to provide the drive for the roll and pitch axes. This will provide the torque and speed requirements of the application, and will be protected from the silo environment through the use of a sheath. A device that can de-couple the motor from the roll and pitch axes will be used to ensure that a wrist position that will allow for the extraction of the EMMA™ from the silo in an emergency situation can be maintained. The roll of the system uses a slip key system that will easily allow for the +/- 360-degree rotation. Electrical trigger switches will be used for the end of travel. Drives for the electrical motors will be contained in the actuation package.

5.5 Sheath

The sheath is an important facet in the manipulator system decontamination process. The sheath is a segmented unit that covers the exposed sections of the mast, five stages of the manipulator, and the wrist assembly to provide a smooth, decontaminable surface by reducing the number of debris traps. Stages 1-3 will have a flexible sheath material in the regions around the hinges that go through bending. The segment portion of these stages will be protected by the outer aluminum hatch. The segments are joined with a waterproof, durable system. This approach reduces maintenance time for manipulator repairs—the entire sheath will not have to

be removed, only the section covering the segment under observation. In many cases the maintenance hatches on the stages themselves can be opened to inspect internals. These hatches are sealed and fastened down for operation. The same approach is taken for segments 4 and 5 that have at aluminum skins around the structural segments and the flexible sheath around the elastomer couplings.

The flexible sheath is constructed of a neoprene coated hypalon fabric. This material was selected based on the following performance criteria:

Ability to withstand 3,000 psi pressure washing from a distance of 6 inches
Demonstrated ability to retain shape and material consistency under extreme pressure and bends
Water resistance
High resistance to tearing, pinching, and puncture
Rip-stop capability if punctured or torn

Manufacturer data reveals that the selected sheath material can effectively meet these requirements.

The sheath material must also withstand pinching between the segments and guide bearings. Design measures combined with the durability of the selected sheath material will minimize damages caused by this scenario. A specific design measure involves the guide bearing. The rollers of he guide bearing are round, made of aluminum core covered with a firm polyurethane coating. This design minimizes the localized loads to the sheath as the manipulator is inserted and retracted from the silo. Polyurethane exhibits local deformation under high loads and provides a larger contact area for the sheath surface, which minimizes the potential tearing or piercing of the sheath.

This closure system simplifies maintenance for manipulator cable or internals maintenance activities, and is also water-resistant and can withstand the decontamination pressure forces.

Sheaths between the mast and segment 1, between segment 1 and segment 2, segement 2 and segment 3 will be very similar. They will have to allow a piloting motion a single axis in the range of 0 to 45 degrees. It will be attached to the backshell at the bottom and to the hatch doors at the top of the segment. There will be no exposed parts of the segment except the end of the backshell which also acts as a hardstop.

Sheaths used for stage 4 and 5 segments will be identical. They are needed to allow bi-axial motion in the range of negtive 30 to postive 30 degrees along both axes. In these segments no part is exposed to the outside environment except the aluminium skins of the segments. These skin is sealed around the segment structure.

Design of the individual sheath pieces is done with a pleated bellow shape. This shape allows for the stretch and compression of the sheath without loading the hypalon material.

INSTRUMENTATION & CONTROLS SYSTEM

Overview

The control system for the arm is made up of three major functional systems: the Arm Control System (ACS), the Local Operating Station (LOS), and the Remote Operating Station (ROS). The Programmable Logic Controller PLC system directly controls the arms movement by interfacing with the arms sensors, Human Machine Interface (HMI), actuators, and servos. The system is broke down into three separate PLC controllers, the ACS, LOS and ROS PLC systems. Each system is located in a panel of the same name. LOS PLC and ROS PLC are a redundant systems. Only the ACS PLC is a separate and critical system. The PLC's are connected via Profibus communication system. The PLC's generate data in a special HMI data block, thus transferring all information directly to the HMI computer in real time. All operation is done through an HMI panel that can be connected to the LOS or the ROS.

The ACS consists of a PLC, power supplies, and various I/O modules for electronic components. The LOS consists of a PLC, power supplies, I/O modules, E-stop and a cluster of indicators. The LOS is designed for maintenance and diagnostic purposes, although the station can control the arm. The ROS consists of a PLC, power supplies, I/O modules, E-stop, and a cluster of indicators. An operator panel has been designed that can be attached to either the LOS or the ROS control panels. This panel contains the E-Stop, joysticks, and momentary switches. The devices on this panel are used to control the motion of the manipulator. In addition to the operator panel a computer system is also used to perform more advanced data analysis with the ability to generate alarms and warning. This is the interface used for troubleshooting and system diagnostics. The ROS monitors the system status, observes system trends, and provides information through the attached computer. This system has been designed for the primary location of control. Ease of operation has been incorporated into the design with respect to minimized controls and ergonomic layout.

The Siemens PLC system provides a robust platform for implementation that can be adapted when functionality needs to be added or altered. All data communication between the arm and the active Operating Station pass through a ProfiBus DP System. ProfiBus DP is a robust and widely accepted fieldbus standard that provides high-speed data communication over medium range distances on the order of 1000 meters.

All control system equipment is Year 2000 (Y2K) compliant and is Factory Mutual approved or Underwriter Laboratories listed. The system has been designed to achieve better then 99% availability.

Primary methods of operation, including those for startup, shutdown, maintenance, and normal retrieval operation activities, have been considered. Ease of operation has been considered with respect to the method that each of the motions is controlled. Location of the video monitors has been considered to achieve the primary feedback mechanism for the operator. Software initiated alarms and warnings have also been incorporated to assist the operator in avoiding silo damage through hazardous manipulator configurations. The primary motions used to perform dexterous motions with EMMA™ is through a proven method of joystick controls that allows operators to position stages 4 and 5 of the manipulator with excellent resolution.

Arm Control System: 3157

Overview

The ACS directly controls the arm's movement by interfacing with the arm's sensors, operating stations, actuators, and servos. The system is located near the arm in the tower and moves up and down with the arm elevation system. The system communicates with the active Operating station to provide the user with control of the arm. A Lock Out switch controls which Operating Station is active. This ensures that only one location maintains control of the system.

Sensors and Actuators

From a control perspective, the arm consists of hydraulic valves, force sensors, and position sensors, thermal sensors, and drive encoders. Drive encoders are used on the z-drive, wrist motors, and azimuth drive. Hydraulic actuators pull on cables controlling the curvature of the various arm segments. Tension on each of the cables is monitored with force sensors. Position sensors indicate the extension of each cable.

ACS System

Data from the force sensors, position sensors, drive encoders, and the joysticks are all used to control the hydraulic actuators that move the arm. This data is collected and managed by the entire PLC system. The ACS PLC system manages all of the specific information from the arm's sensors (cable tension, cable position, and temperature) and calculates cable length information. The ACS PLC System maintains the arm's position or assist in fluid movement in accordance with the operator's direction motion. In the event of a communications break or a system crash at either the LOS or ROS, the ACS PLC System will maintain the arm's position.

Alarms and Warnings

Additionally, this PLC system is responsible for generating low-level alarms. Low level alarms include out of range data, excessive force, and spikes in the sensor readings. The ACS PLC system is connected through ProfiBus to the controlling operating station. The ACS PLC System transfers alarm information and cable length information through the ProfiBus to the operating station. The operating station uses the ProfiBus to transmit arm control information to the ACS PLC System.

000542

3157

Local Operating Station

Overview

The LOS is located at the tower base. This system provides both operator interface capabilities and direct interface with control drives and sensor. The LOS has a lock out switch. In normal operation, the lock out switch prevents the station from affecting the operation of the arm. For maintenance and diagnostic work, the lock out switch can be set to activate the local controls. When active, the LOS provides range limited option for control of the arm. The range-limited control is a safety feature for maintenance. This system can be configured to fully control the manipulator. Configuring the system in such a manner requires that a computer, and camera monitors are connected to the system.

LOS System

The ACS PLC System communicates with the LOS PLC over the ProfiBus. This allows the ACS PLC System to respond to operator control. Also, the ACS PLC System generates alarms and relays them to the operating station PLC. The LOS PLC System as one of the operating station has interfaces that can connect with the control panel and computer system if necessary. It is capable of translating information from the ACS and communicating at a higher level with the operator. In addition to the operation activities the LOS also has a direct interface with the arm elevation, rotation, and various I/Os for the tower. A-drive and z-drive both have a variable frequency drive that controls the motors. These drives are connected to the LOS. Maintenance floors in the deployment tower have switches to verify correct position during operation or maintenance. This information is communicated to the ROS assuming that is the location of control. All possible information that can be practically provided directly to this PLC is provided to allow easier access to systems during troubleshooting of the systems. The LOS is at the tower base and is much more accessible than the ACS.

Alarms and Warnings

The LOS has a set of indicator lights that display immediate problems. For reliability, the alarms are generated and displayed through PLC systems only; alarm information is isolated from the PCs. The alarms are generated by the ACS and LOS PLC systems and monitored by the PLC System located in the active operating station. Alarms include out of range data, excessive force, spikes in the sensor readings, or a fault in operation.

Remote Operating Station

Overview

The ROS is the central control for the arm and is located in the control trailer for the SWRS functions. An identical system is located in the trailer for the FSMS ICAT. All higher functions like data monitoring, archiving, and trending, take place at the ROS. In addition, the ROS includes the operator panel and HMI computers. This has full joystick control and alarm

3157

indicators. The arm operator has complete control of the arm from the ROS. The ROS can be physically located as far away from the arm as 500 meters. The station communicates with the ACS and LOS through a physically wired ProfiBus connection.

ROS System

The operating Station PLC System communicates with the ACS over the ProfiBus. The operating station PLC System relays alarm messages from the ACS and LOS to the operator via the alarm indicators and HMI computer acknowlegement screens. The operating station PLC system also responds to the operator by sending motion control signals to the various control systems This system also contains an 8-bit I/O data transfer with the larger site PLC system. This data is used to control interfaces with other site equipment. The main signals are operation status of the equipment.

Alarms and Warnings

The ROS has a set of indicator lights that display immediate problems. For reliability, the alarms are generated and displayed through PLC systems only; alarm information is isolated from the PCs. The alarms generated by the ACS PLC system and LOS PLC system are monitored by the PLC system located in the active operating station. Alarms include out of range data, excessive force, and spikes in the sensor readings. This is communicated to the HMI computer, but if actions are required the PLC system immediately takes actions.

Operator Panel and HMI Equipment

Operator Panel

The operator panel is a remote panel tied into the operation system control panel. All major control I/Os are distributed through the operator panel. Both digital and analog signals are used. Control input devices for the z-drive and azimuth drive are mounted on this panel. Control switches for stage 1 through 3 are located on this panel and two joystick are include for the wrist and stage 4 and 5 control. The operator panel is mounted in front of the operator and contains control I/Os needed to directly control manipulator positioning. All switches are momentary or wobble switches. This means that the switch is spring loaded to return to the default or off position. Systems using this control are not designed for continous movement during operation, but for corse positioning. The operator moves the switch in the direction the arm need to move, and then the operator releases the switch and arm movement stops. The PLC's control speed, ramp up and deceleration control.

Two joysticks directed by the operator control the EMMA™ manipulator and wrist. Each joystick has two degrees of freedom. These two analog signals are used to control stage 4 and 5. The joystick also have rocker switches located on the joysticks that control wrist motion. They are similar to momentary switches on the panels, but their locations allow control of the wrist while simultanously controlling the positions of stage 4 and 5. Using the joysticks and switches on the

operator panel, the operator can control any of the five stages of the manipulator or the wrist. The joystick outputs have input directly to the ROS or LOS PLC.

Computers

HMI PC

The HMI PC provides a graphical user interface. The operator views analog measurements, discrete events, and a 3D representation of the manipulator and silo. The 3D representation of the arm is determined using the forward kinematics derived from sensor readings. The ROS HMI PC stores data on its hard drive, and this data is then archived on a CD via the read/write CD drive.

The HMI PCs are equipped with Pentium processors, Windows NT, minimum 10G hard drives and read/write CD-ROM drives. The PCs also have password protection and keylock security. All hardware and software is Y2K compliant. The PCs have the proper hardware configuration to allow for expansion of ProfiBus communication cards.

The HMI graphical user interface (GUI) is programmed using WinCC. The GUI is designed to include analog and discrete measurements, alarms, and the graphical representation of the arm. The PC obtains monitoring data from the PLC through the PC to PLC ProfiBus connection.

Programming PC

The programming PC is used to make changes to the PLC program and it is operated independently from the HMI PC. Programming is done in the STEP 7 programming language used to program Siemens PLC systems. The programming PC is also a fully functional backup to the HMI PC, available as a trouble-shooting tool.

The programming PC is configured under the same hardware requirements as the HMI PC.

Laptop Maintenance PC

This computer is used for system setup and diagnostics. It will be included with the stored LOS operator panel and is designed to connect with the LOS in the event that the computer interface is necessary for operation at this location.

Alarms and Warnings

Alarms and warnings that are found through PLC system are all communicated to the HMI computer. Through the GUI all these faults can be acknowledged by the operator.

EMMA Operation

3157

Overview

The EMMA manipulator has 11 possible degrees of freedom. These include manipulator rotation, vertical position, Stages 1,2,3 pitch (up and down movement), Stage 4,5 pitch and yaw (side to side motion), and the wrist roll (rotation) and pitch. These motions are controlled in a fashion that best incorporates the natural intuition of these motions and the frequency of their use. Include in the table is each of the motions, how they are controlled, and a description of functions.

Motion	Controlled By:	Function
Azimuth drive or Manipulator Rotation	Momentary switch can be moved left or right	Rotate the manipulator to angle angular position inside the silo. Provide sweeping arcs at the end of the systems.
Z-drive or Manipulator vertical position	Momentary switch can be moved up or down	This provides the ability to insert and extract the manipulator from the silo environment. This drive would also allow for achieving various level of insertion based upon the height of the waste.
Stage 1	Momentary switch can be moved up or down	This movement allows the manipulator to extend out horizontally inside the silo. This stage provides the least resolution, but the largest movement.
Stage 2	Momentary switch can be moved up or down	This movement allows the manipulator to reach a full 90-degree bend. This stage provides gross positioning of the manipulator.
Stage 3	Momentary switch can be moved up or down	This stage can allow the manipulator to bend upwards to the silo dome if necessary. This stage provides gross positioning of the manipulator.
Stage 4	Joystick 2 up and down motion translates to pitch and left or right translates to yaw	This is a 9-foot long stage that has the dexterity of the 3 segmented flexible structure. It can achieve a 90-degree bend in pitch and a 45-degree in yaw.
Stage 5	Joystick 2 up and down motion translates to pitch and left or right translates to yaw	This stage is the last stage of the manipulator and can bend to 90 degrees in any direction. This stage is 7 feet long.
Wrist Roll	Joystick 1 rocker switch to roll clockwise or counterclockwise	This motion allows for the articulation of the gripper and any retrieval equipment used at the end of the arm.
Wrist Pitch	Joystick 2 rocker switch to move up or down	This motion allows for the articulation of the gripper and any retrieval equipment used at the end of the arm

Manipulator Control

The primary control of the manipulators resides in the ROS. Commands, control algorithms, alarms and warning systems are distributed between the 3 different PLC and the HMI computers. The methods of operator interfaces include two modes. One is the teleoperative mode that is for normal operation. The second is maintenance mode. This has been included to ease diagnostics during troubleshooting and complimenting maintenance procedures that require some manipulator articulation.

Manipulator Control Modes

Teleoperative Mode — In this mode the operator controls each motion of the system through the various input devices such as joysticks or momentary switches. When the arm are in teleoperative mode, a controller is used to generate a control signal to the hydraulic valves or servo motor drives. The controller uses the operator's joystick or switch input to generate appropriate signals. The controller sends signals to each drive or valve that compensates for various mechanical effects and allows smooth movement of the stage.

Maintenance Mode —In maintenance mode, the operator can send signals directly to the servo valves. There is no coordinated control of the actuators in maintenance mode. This means that smooth control of the manipulator is not possible. Maintenance mode is used to troubleshoot arm failures and verify the overall functionality of the hydraulic system.

Alarms and Warnings

The primary method for operation feedback to the operator is accomplished through the use of the camera monitors. This allows for the operator to make judgements on the configuration and positioning of the system. Several features are included into the control system of EMMA that assists the operator. These systems are included to add redundant feedback with respect to the arm position insuring that the silo structure is not damaged.

The EMMA system provides feedback to the operator with alarms and warning triggered by various scenarios. These alarms or warning are acknowledged through the HMI computer at the ROS. This feedback could be presented due to mechanical or electrical problem with the EMMA systems or due to the arm position approaching a collision with the silo structure. This is particularly important during the insertion and extraction procedures.

The two types of operator feedback relate to system faults and configuration warnings. System faults are problems with the EMMA system that were found through system diagnositics. The functionailtiy of electrical motors, drive system, communication system, etc. Warnings or alarms may result from these errors. Maitaince procedures will correlate with the computer indicated problems so that appropriate action can be taken. All faults of this type will be communicated throught the HMI computer located in the ROS.

The other type of feedback is warnings or alarms that relate to the manipulator being in a hazardous configuration. This feeback is important to protect the silo integrity. The first warning system is the visual feeback that the operator recieves through the camera monitor. In additon

3157

to this the EMMA system has another method of determination. This is a 3-D Forward Kinematics Model

The forward kinematics algorithm predicts the position of the end of the manipulator within the silo based on sensor measurements. The rotational joints of the first three stages are equipped with absolute rotary encoders and the segments of the universal stages are equipped with U-joints with 2 rotary encoders for each joint. Therefore it will be possible to determine the arm position using standard kinematic analysis based upon this angular feedback information. All sensors and associated electronics equipment will be properly shielded to facilitate reliable operations in the silo's radioactive environment. This predicted arm configuration can then be compared to the known obstacles or dimensions of the silo environment.

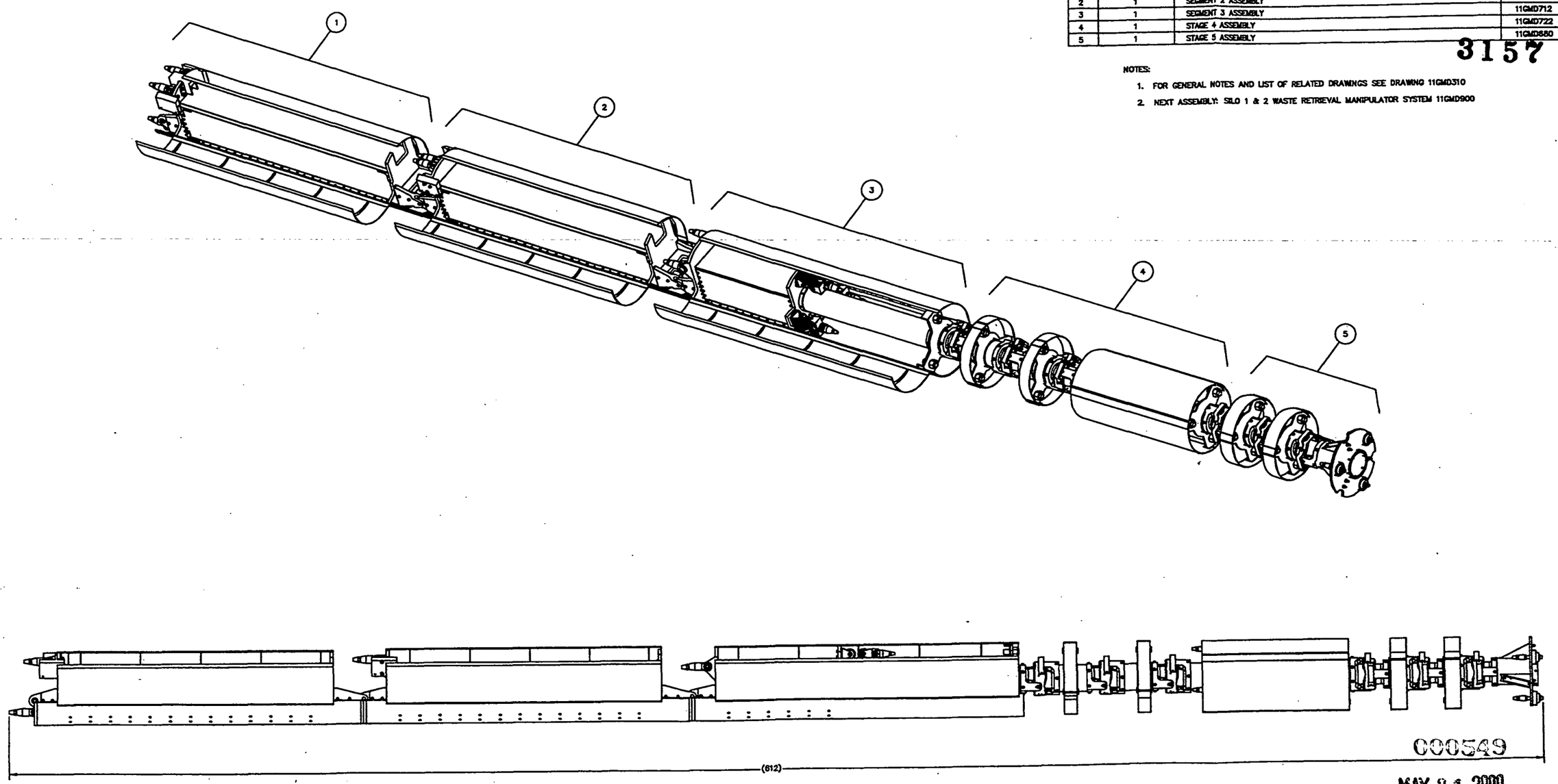
INFORMATION ONLY

MATERIALS LIST			
MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
		EMMA ASSEMBLY	11GMD700
1	1	SEGMENT 1 ASSEMBLY	11GMD701
2	1	SEGMENT 2 ASSEMBLY	11GMD709
3	1	SEGMENT 3 ASSEMBLY	11GMD712
4	1	STAGE 4 ASSEMBLY	11GMD722
5	1	STAGE 5 ASSEMBLY	11GMD680

3157

NOTES:

1. FOR GENERAL NOTES AND LIST OF RELATED DRAWINGS SEE DRAWING 11GMD310
2. NEXT ASSEMBLY: SILO 1 & 2 WASTE RETRIEVAL MANIPULATOR SYSTEM 11GMD900



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REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
0	5/31				CERTIFIED FOR CONSTRUCTION

DRAWN BY: 5/31/00
DESIGNED BY: 5/31/00
CHECKED BY: 5/31/00
APPROVED BY: 5/31/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE: SILO WASTE RETRIEVAL SYSTEM
ASSEMBLY
EMMA ASSEMBLY

SIZE	SCALE	DWG. NO.	REV
D	3/5"=1'-0"	11GMD700	0

FILENAME: 11GMD700.DWG

INFORMATION ONLY

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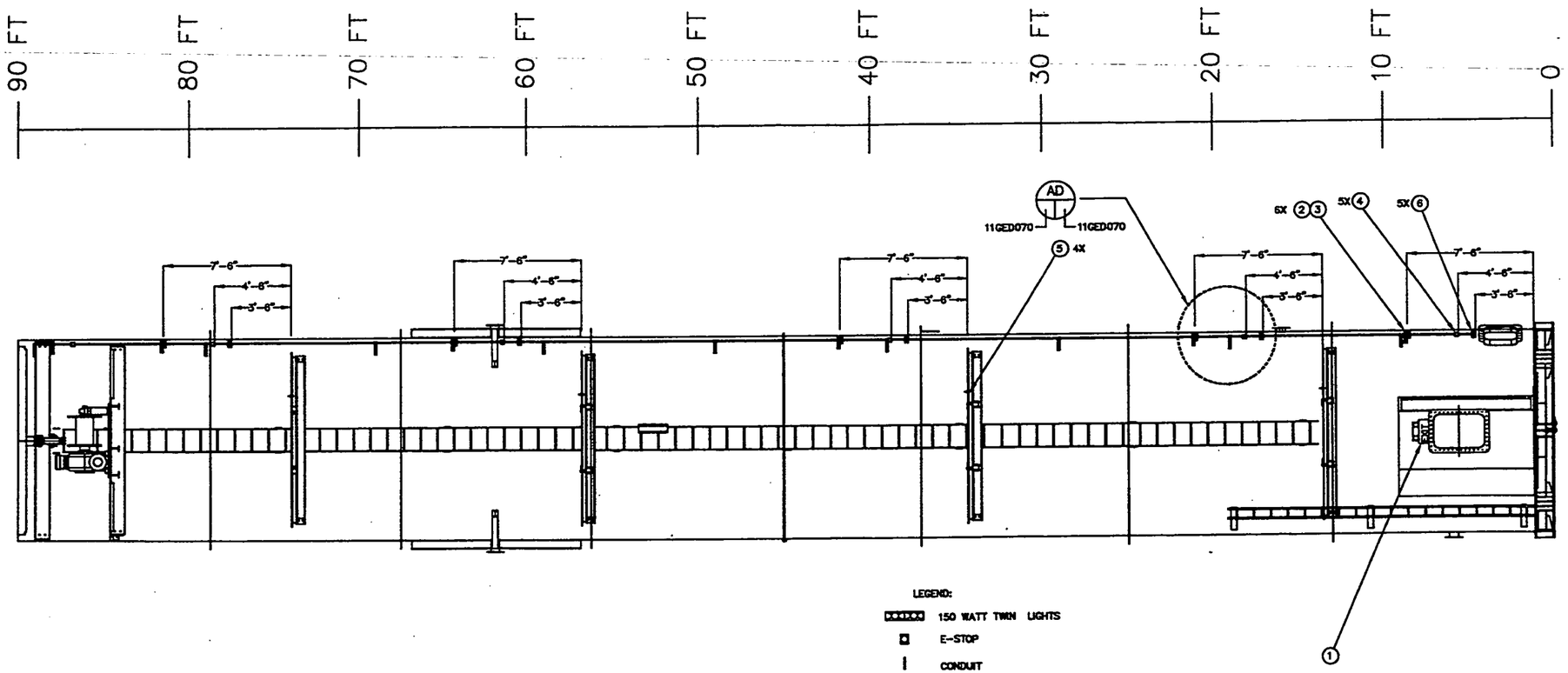
MATERIALS LIST			
MARK NO.	QUANTITY	DESCRIPTION	REFERENCE
1	1	COMBINATION EXIT AND EMERGENCY LIGHTS (McMASTER-CARR)	6367K26
2	6	150 WATT TWIN TUBE (McMASTER-CARR)	1594K43
3	6	LONG-LIFE COMPACT EMERGENCY LIGHT (McMASTER-CARR)	1488K31
4	5	30 mm ASSEMBLY PUSH-BUTTON SWITCHES NORMALLY CLOSED (McMASTER-CARR)	7403K37
5	4	INDUCTIVE SENSORS (TURCK)	NI 4-M12-VN6X
6	6	NEMA STYLE RECEPTACLE (McMASTER-CARR)	7120K92



LEGEND:

- 150 WATT TWIN LIGHTS
- E-STOP
- CONDUIT
- EMERGENCY LIGHT
- MAINTENANCE HOIST PLUG
- EMERGENCY FLOOR SWITCH

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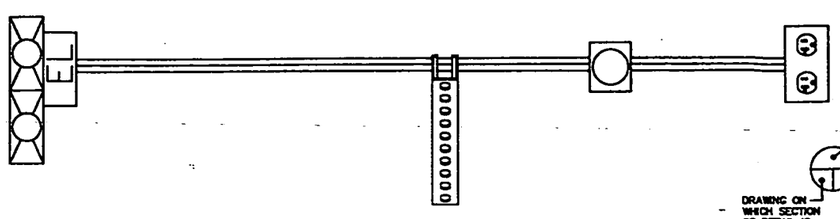
MAY 30 2000

AD VIEW
SCALE: NONE
11GED070 11GED070



LETTER OR NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION & DETAIL KEY

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
0	5/4/00				CERTIFIED FOR CONSTRUCTION

RFE

DRAWN BY — DATE 5/30/00
REVIEWED BY — DATE 5/30/00
CHECKED BY — DATE 5/31/00
APPROVED BY — DATE 5/30/00
APPROVED BY R.S. — DATE 5/31/00

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
TOWER LAYOUT
GENERAL ARRANGEMENT

SIZE	SCALE	DWG. NO.	REV
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FILENAME: 11GED070.DWG

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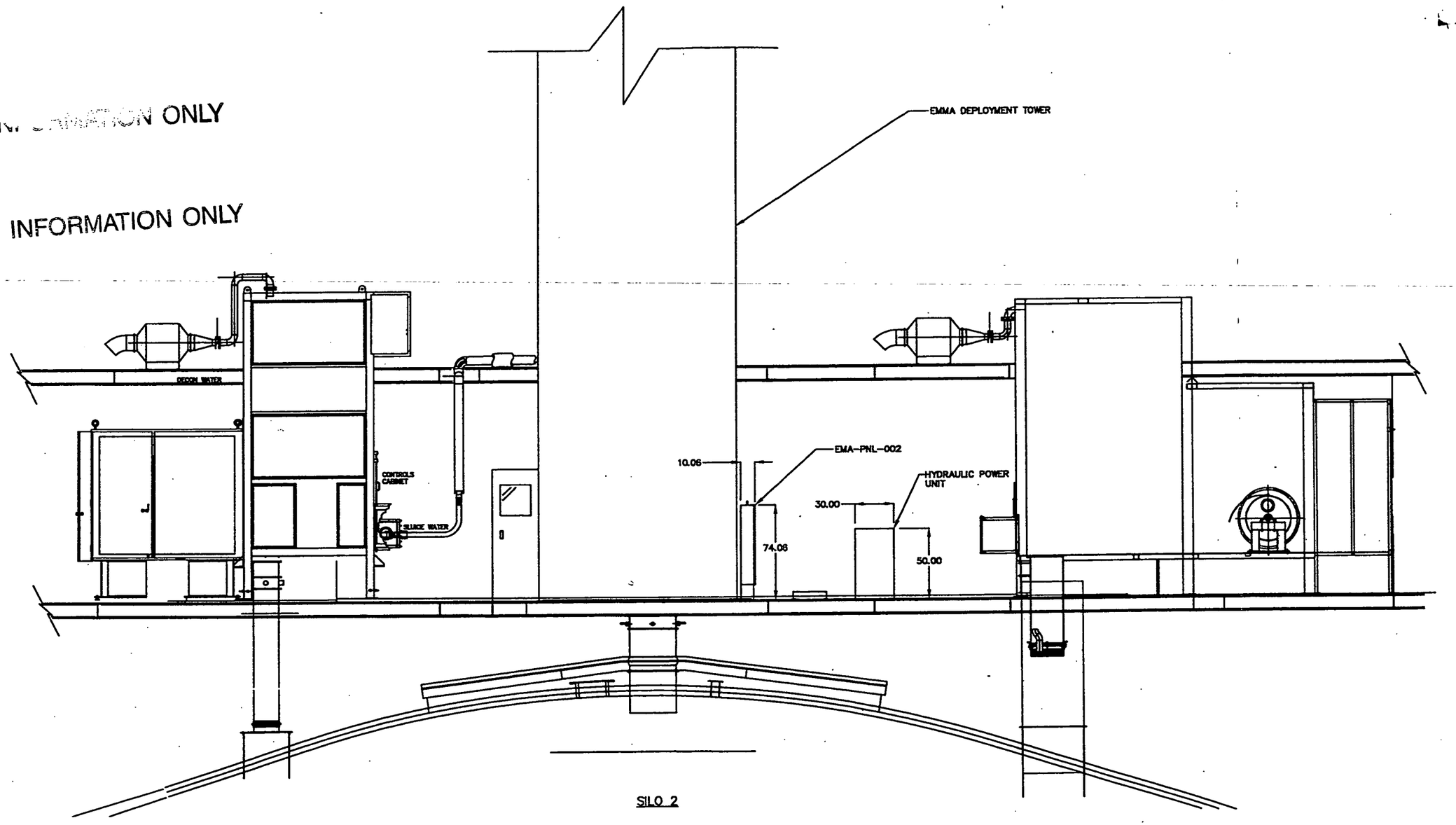

SILO 2

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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE: SILO WASTE RETRIEVAL SYSTEM LAYOUT (SHEET 1 OF 2) – LOS LAYOUT

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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DESIGNED BY: 5/31/00
CHECKED BY: 5/31/00
APPROVED BY: 5/31/00
APPROVED BY: 5/31/00

SIZE: D | SCALE: NONE | DWG. NO. 11GED090 | REV 0

FILENAME: 11GED090.DWG

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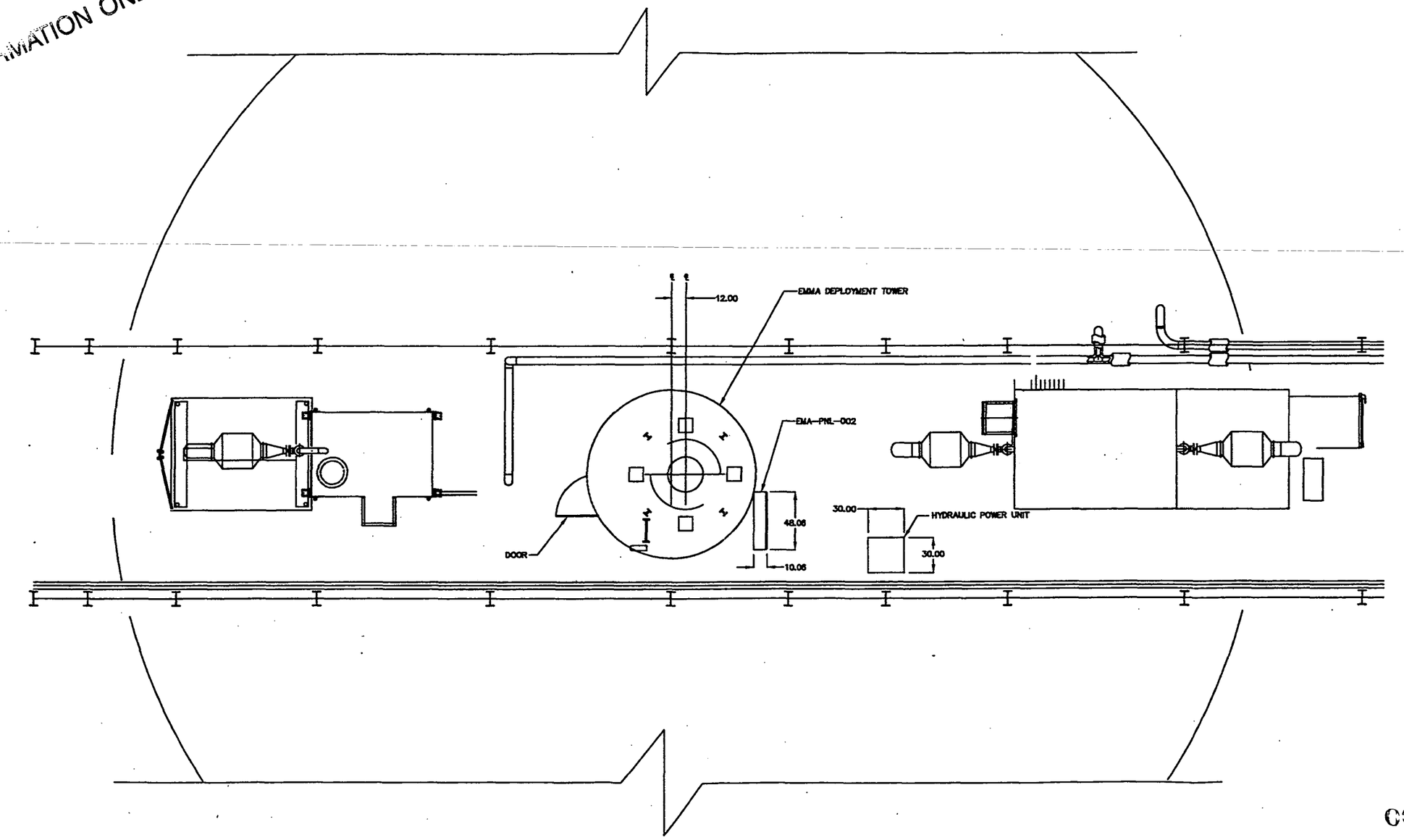
INFORMATION ONLY



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RFC

DRAWN BY 5/30/00
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CHECKED BY 5/31/00
APPROVED BY 5/30/00
APPROVED BY 5/30/00

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
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TITLE
SILO WASTE RETRIEVAL SYSTEM
LAYOUT (SHEET 2 OF 2) –
LOS LAYOUT

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FILENAME: 11GED091.DWG

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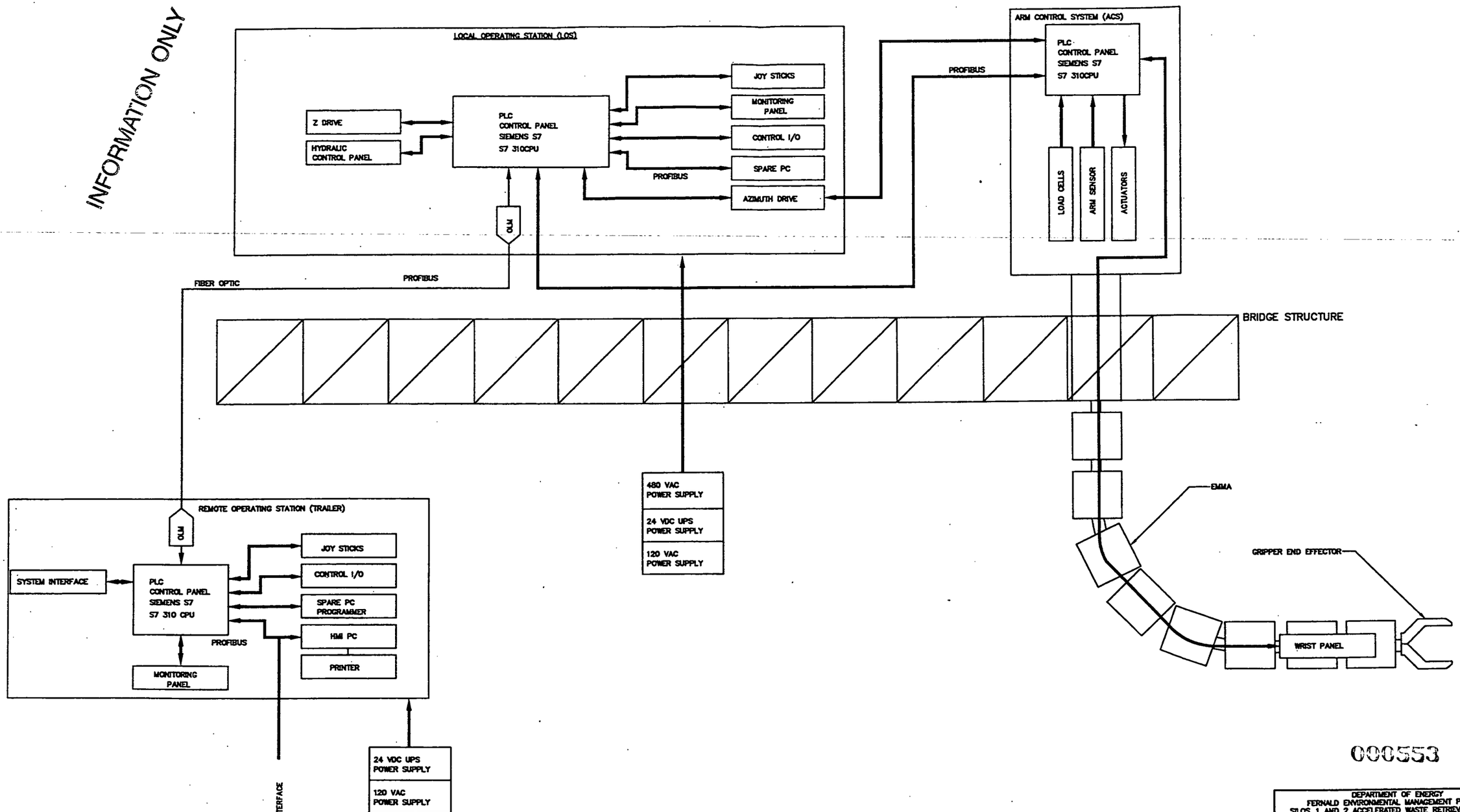

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REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
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0	10/19	VE	DH	MH	PRELIMINARY DESIGN SUBMITTAL

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

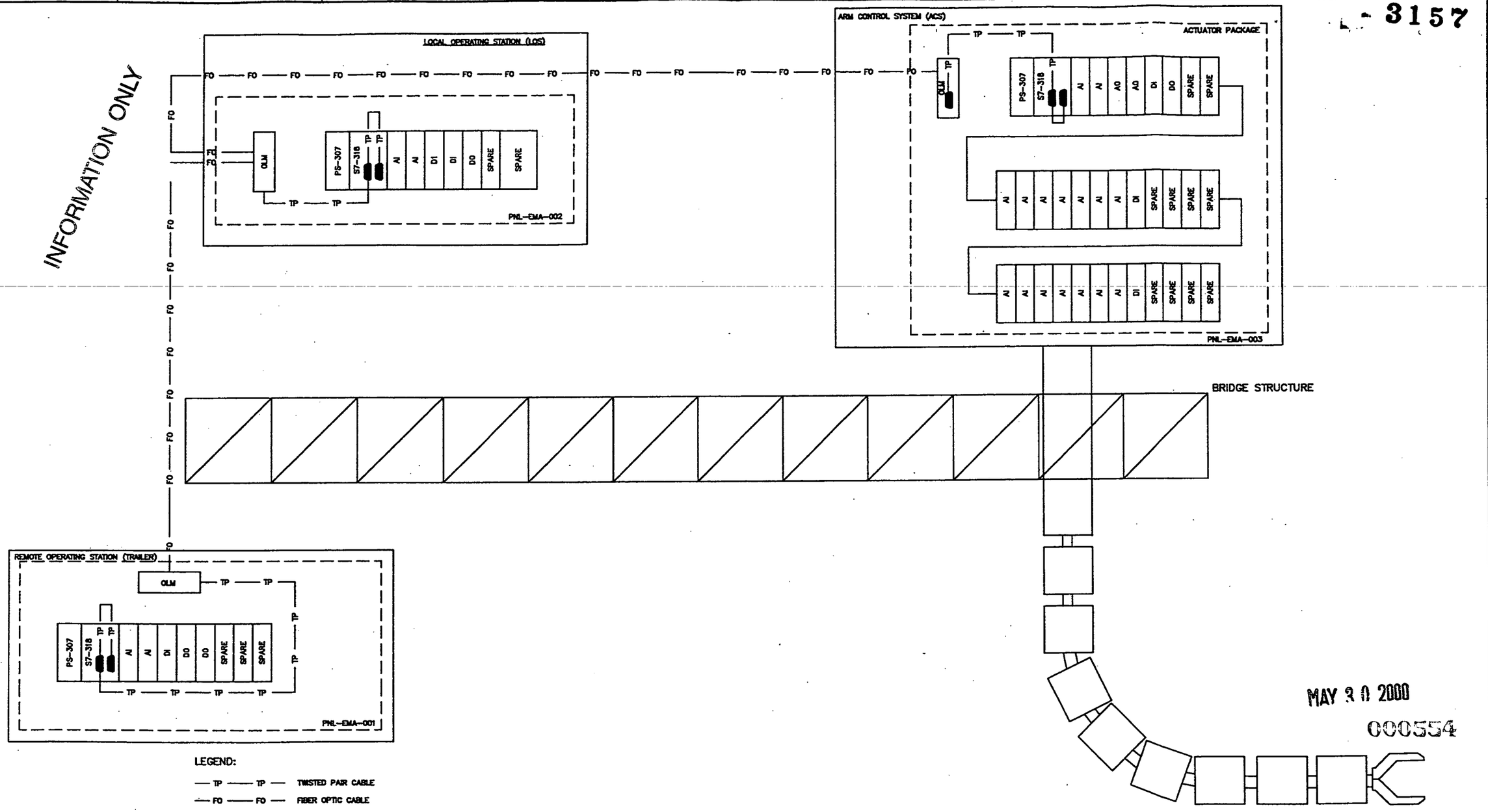
TITLE
SILO WASTE RETRIEVAL SYSTEM
BLOCK DIAGRAM
CONTROL SYSTEM

SIZE: | SCALE: NONE | DWG. NO. 11GID010 | REV 1

FILENAME: 11GID010.DWG

3157

INFORMATION ONLY



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REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE
1	5/30	VE	DH	MH	CERTIFIED FOR CONSTRUCTION
0	10/19	VE	DH	MH	PRELIMINARY DESIGN SUBMITTAL

DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
FDF CONTRACT NO. FSC 624

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

TITLE
SILO WASTE RETRIEVAL SYSTEM
ONE LINE DIAGRAM
CONTROL SYSTEM

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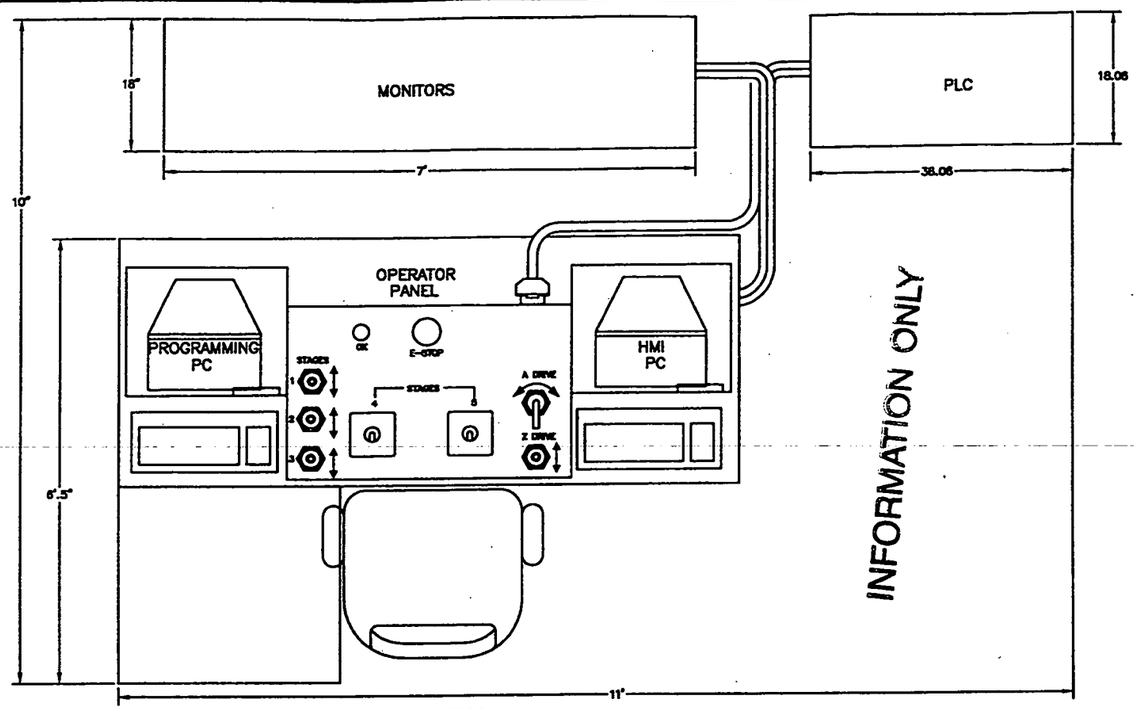

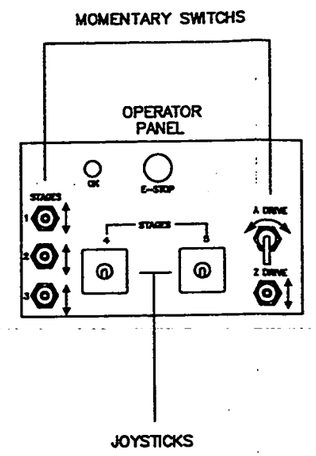

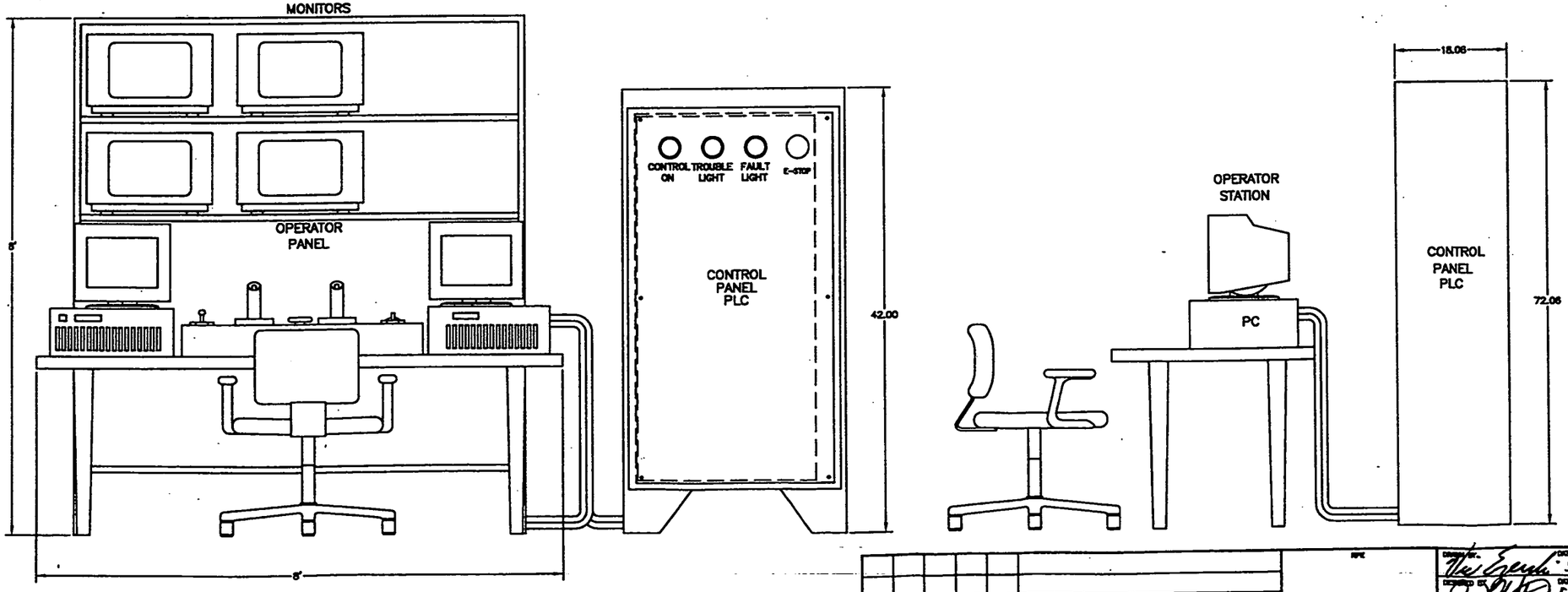

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MAY 2 0 2000

MAY 3 0 2000

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FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
FERNALD, OHIO
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FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

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GENERAL ARRANGEMENT

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PROCESS CONTROL PLAN (BALANCE OF PLANT)

DOCUMENT NO. 624-P622-36

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

SUBMITTED TO:

FLUOR FERNALD, INC.

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TABLE OF CONTENTS

1.0 HMI CONTROLS 4
- 1.1 Sluicing (Bulk Material Retrieval) 5
- 1.2 Sluicing (Heel Retrieval) 6
- 1.3 Sluicing (TTA Tank Material Retrieval) 8
- 1.4 Decontamination (Decon Spray Ring Operations) 9
- 1.5 Decontamination (ADS Operation) 9
- 1.6 TTA Operations 10
- 1.7 Troubleshooting 10
- 1.8 Motor Control Operation 11
- 1.9 E-Stop and Q-Stop 11

2.0 LOCAL CONTROLS 12
- 2.1 Sluicer Module 12
- 2.2 Decant Pump Module 13
- 2.3 Slurry Pump / CAT Module 14
- 2.4 High Pressure Water Pump Skid 15
- 2.5 Hydraulic Power Unit Skid 16

3.0 EQUIPMENT DESCRIPTIONS 17
- 3.1 Central Control Systems 17
- 3.2 Sluicer Modules 21
- 3.3 Decant Pump Modules 24
- 3.4 Slurry Pump / CAT Modules 27
- 3.5 High Pressure Water Pump Skids 30
- 3.6 Hydraulic Power Unit Skids 35

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LIST OF ACRONYMS

HMI	Human Machine Interface
PLC	Progammable Logic Controller
TTA	Transfer Tank Area
FSMS	Full Scale Mockup System
HPW	High Pressure Water
SREE	Slurry Recovery End Effector
HPU	Hydraulic Power Unit
ADS	Arm Deployment Sluicer
UPS	Uninterruptible Power Supply
MPI	Multipoint Interface
RCS	Radon Control System
ES	Engineering System
OS	Operating System
SWRS	Silo Waste Retrieval System
TWRS	Tank Waste Retrieval System

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1.0 Human Machine Interface Controls

The Human Machine Interface (HMI) will have a main screen from which the operator will select a mode of operation. The basic modes of operation will be:

- Sluicing (bulk material retrieval)
- Sluicing (heel retrieval)
- Sluicing (TTA tank material retrieval)
- Decontamination (decon spray ring operations)
- Decontamination (Arm Deployed Sluicer operations)
- Troubleshooting (password protected)

The sluicing screens will graphically display the source tank and receiving tank conditions, pumps and pump status being used to perform the particular sluicing operation, interconnecting piping with automatic valve and process parameter status graphically displayed, and alarm conditions. Upon selecting a mode of operation, a material flow path will be selected for the particular operation. For instance, operator selection of bulk material sluicing operation will activate a password protected pop-up screen that will contain all the choices for normal material flow paths. The shift supervisor will then key in a password and select the desired material flow path (ie; sluicing from silo 4 to tank 1A). The shift supervisor, in performing this selection, will verify that conditions for operation have been met and operations may proceed. The valve line ups for that flow path then will automatically be made by the PLC logic and equipment operation permissive condition will be allowed. Subscreens will be available for more detailed information regarding each major equipment system (sluicer module, HPW pump skid, decon pump skid, slurry pump module, decant pump module, water filtration system, and make-up water system).

In general, each pump display will include a stop/start switch and will indicate run status and speed and direction as appropriate. Each process instrument display will include the instrument located schematically on the piping with its output signal numerically displayed on the sensor icon. Each automatic valve display will indicate its status (open, closed, or flow direction for diverter valves) by the color of the icon. The process piping will display flow status and fluid type by changing color. Each tank will include liquid level, solids level, and internal pressure signals displayed.

The HMI consists of two computers that are in redundant operation. Either or both computers can be used to control and monitor the same or different equipment operations. The redundant operation allows either computer to fail without affecting operations. When the failed computer is returned to service, the operating computer updates the other computer with all operation-collected data and operating status.

The sluicing, slurry, and decant modules are unique items of equipment because the modules are relocated to new locations as operations proceed. The three sluicer modules can be located in ten different locations (on silo 4, silo 1 & 2, and TTA). The three slurry modules in six different locations and the two decant

modules in four different locations. The PLC and HMI recognize where each module type is located and will properly control the connected module. Assigning a range of Profibus addresses to each module where each address for a module is defined as the module type and its location does this. The FSMS and AWR HMI and PLC programs are identical. If a module is not in an assigned location on the Profibus, the PLC and HMI will ignore any request for module control or data. When a module is moved to a new physical location, the address of the data collection and control node inside the control cabinet will need to be changed to the predefined address for that location. This address change is performed with dip switches on the node and done before power is applied to the module.

1.1 Sluicing (Bulk Material Retrieval)

The bulk material retrieval screen will contain a graphical representation of the source silo and receiving and sluice water TTA tanks. The source silo will include graphical displays of the sluicer and slurry pump modules with slurry and sluice water process lines and associated automatic valves contained within these modules displayed. The receiving and sluice water TTA tanks will include graphical displays of the decant pump modules with slurry and sluice water process lines and associated automatic valves contained within these modules displayed. The screen will also have simplified schematic display of the silo/TTA interconnecting piping. The piping schematic will include diverter valve and process instrumentation icons. The sluicer graphic display will include the sluicer pitch/yaw drive positions, internal sluice water lines and automatic block valve display, and sluice water supply pressure. The decant pump module graphic display will include a decant pump display, the internal slurry and sluice water piping and automatic diverter valves displays, and flow and pressure sensor displays at their correct location on the piping, decant pump hoists up/down operation icons, hose reel in/out operation icon, and module HEPA filter differential pressure signal displays. The slurry pump graphic display will include the slurry pump and speed control display, the internal slurry and sluice water piping and automatic diverter valves displays, mass flow and pressure sensor displays at their correct location on the piping, pump lift table level sensor display, pump inlet level sensor display, and inlet screen solids detection switch state display.

When the operator wants to initiate sluicing, he/she will open the sluice water block valve from the valve display on the sluicer module graphic. Verify that the correct flow path is achieved by looking at the tank labeling and the piping/diverter valve graphical displays, and verify sluicer nozzle functionality by moving it to a desired position and watching the position display response and observing from the in-silo cameras. The decant pump will be started from its display on the decant pump module graphic and the operator will verify sluice water flow and pressure from those signals displayed on the decant pump module graphic. The operator will verify that the decant pump is at a desired elevation for operation in the TTA tanks using the TTA tank overview camera. He/she adjusts the pump elevation using the by depressing the hoist up/down icon as needed. Operating the hose reel, the operator will also pay in/out decant

pump discharge hose to accommodate changing pump levels. The hose reel is operated by depressing either the pay hose "in" or "out" icon. The sluicer nozzle will be operated from a joystick at the HMI station. When the slurry pool depth reaches a desired level, as seen from the level sensor on the slurry pump module graphic, the operator starts the slurry pump by enabling it and selects a pump drive speed from the slurry pump display. The operator will verify the slurry pump discharge flow and pressure from the numerical values displayed on the mass flow meter and pressure transmitter icons in the slurry pump module graphic. The operator will continue to monitor the slurry pump output pressure and flow and inlet level as sluicing progresses. Should the slurry level become high or low, the operator will adjust the pump speed accordingly. Should the slurry line become plugged, the operator may chose to temporarily suspend sluicing by shutting down the slurry pump and selecting the forward flush icon on the screen. This will automatically divert the sluice water flow from the sluicer to the slurry pump module and on through the slurry transfer line to the TTA receiving tank. He/she will continue this until the slurry discharge is clear as seen from the TTA tank camera. The operator can back flush the slurry pump by selecting the back flush icon on the screen. This action will divert the sluice water to the pump discharge. The operator must run the pump in reverse to maximize the pump suction flushing effect.

The HMI will automatically calculate the water and solids removal balance using the mass flow, sluice water flow, and tank level instrument data. The balance will be displayed on the sluicing screen and will alarm at a silo water accumulation value of 3000 gallons.

The bulk retrieval screen will contain an icon for selecting decontamination spray ring operation. When selected, the HMI will automatically bring up the HPW System operation screen. Details fo HPW Pump operations from this screen are provided in Section 1.2.

1.2 Sluicing (Heel Retrieval)

The heel retrieval sluicing screen will contain the same TTA receiving and sluice water tank and silo, interconnecting piping, decant pump modules, and slurry pump module graphics as stated in Section 1.1. However, the heel retrieval screen will also contain sub-tier graphical screens for the HPW pump skid and the HPU skid. Selecting a particular source silo and TTA receiving and sluice water tanks will prompt the PLC to automatically line up the proper diverter valves and piping. In the case of heel retrieval, the sluice water will be directed from the decant pump to the heel waste surge tank mounted to the inlet of the slurry pump.

The HPW sub screen will contain graphics for each of the three HPW pumps; 1) the decon pump, 2) the SREE cutting jet supply pump, and 3) the waste removal jet pump motive water supply pump. Each pump graphic will contain graphics for the basic process water flow piping from supply to pump discharge and return water. The piping graphics will include icons for the HPW automatic diverter valves, the automatic

pressure control valve, and the decon pump's three automatic discharge valves. Icons and numerical output signal displays for each pumps two flow meters, and discharge pressure transmitter will be included in the piping graphics. Presence of water flow and automatic valve position status will be indicated by a change in color on the pipe or valve graphic. The pump graphics will include start/stop icons and run status will be indicated by color change of the icon. The operator changes the automatic valve status by selecting the valve icon which toggles it's position indicated by color change. A system fault status icon will be included to give the operator indication of a system up-set condition.

The HPU sub screen will contain graphics for the hydraulic pump and will contain graphics for the basic hydraulic fluid flow supply and return piping. The piping graphics will include icons for the automatic flow control valve. Icons and numerical output signal displays for the HPU fluid supply flow meter, fluid reservoir level and temperature, and supply pressure transmitter will be included in the piping graphics. Presence of fluid flow and automatic flow control valve position status will be indicated by a change in color on the pipe or valve graphic. A system fault status icon will be included to give the operator indication of system up-set conditions.

To start heel retrieval operations, the operator will start the SREE cutting jet rotation by starting the HPU from its sub screen and selecting a desired flow rate to adjust the SREE cutting head speed. The cutting jets will then be started from the HPW pump skid subscreen by starting the cutting jet HPW supply pump. Starting the HPW pump is done by 1) ensuring the diverter valve is directed to recycle and the pressure command set at zero, 2) starting the HPW pump by selecting the start icon on the pump graphic, 3) changing the diverter valve to supply position by selecting the valve icon, and 4) inputting a pressure value on the pressure control valve icon. The EMMA operator manipulates the SREE within the tank to create a slurry pool from which to remove material. The operator will start the decant pump which will send sluice water into the heel waste surge tank. The slurry pump is started and its speed adjusted to balance the level in the heel tank at about 50%. The decant pump and slurry pump operation will occur in the same manner as described in 1.1 above. The slurry is then pumped into the heel tank by sending HPW to the waste removal jet pump. This is performed by operating the jet pump motive HPW supply pump from the HPW pump skid subscreen. The HPW pump is operated in the same steps as stated above for the cutting jet HPW supply pump. The operator monitors the heel tank level and adjusts the slurry pump speed to maintain level in the heel tank. Should the inlet screen of the SREE become plugged, the operator flushes the screen with the fan jet water supplied by the decon HPW pump. The decon HPW is operated in the same manner as the other two HPW pumps except that the operator opens the fan jet supply valve on the HPW skid before starting the decon HPW supply pump. When the fan jet operation is complete, the operator shuts the decon HPW supply down in reverse order from starting and then closes the fan jet valve. Should the waste conveyance line from the SREE to the heel

tank become plugged, the operator will back flush this line with the conveyance line flush water. This water is supplied from the decon HPW supply pump as well. The line flush is operated the same as the fan jet except the conveyance line flush supply valve is opened and closed instead of the fan jet supply valve. Forward and back flushing the slurry transfer line located between the slurry pump and the TTA is performed in the same manner as stated in Section 1.1.

1.3 Sluicing Tank Waste Retrieval System

The Tank Waste Retrieval System (TWRS) screen will contain a graphical representation of the source TTA tank. The source TTA tank will include graphical displays of the two sluicer modules and the slurry pump module with slurry and sluice water process lines and associated automatic valves contained within these modules displayed. The screen will also have a simplified schematic graphic display of the TTA/treatment plant interconnecting piping. The piping graphic will include diverter valve and process instrumentation icons. The sluicer graphic will include sluicer pitch/yaw drive positions, internal sluice water lines, and automatic block valve display. The slurry pump graphic schematic will include the slurry pump and speed control display, the internal slurry and sluice water piping and automatic diverter valve displays, mass flow and pressure sensor displays at their correct location on the piping, pump lift table level sensor display, pump inlet level sensor display, and inlet screen solids detection switch state display.

When the operator wants to initiate sluicing, he/she will open the sluice water block valve from the valve display on the sluicer module graphic display. The operator verifies that the correct flow path is achieved by looking at the tank labeling and the piping/diverter valve graphical displays, and verifies sluicer nozzle functionality by moving it to a desired position and watching the position display response and observing from the in-silo cameras. The sluicer nozzles will be operated from the joysticks at the HMI station. When the slurry pool depth reaches a desired level, as seen from the level sensor on the slurry pump module graphic, the operator starts the slurry pump by enabling it and selects a pump drive speed from the slurry pump display. The operator will verify the slurry pump discharge flow and pressure from the numerical values displayed on the mass flow meter and pressure transmitter icons in the slurry pump module graphic. The operator will continue to monitor the slurry pump output pressure and flow and inlet level as sluicing progresses. Should the slurry level become high or low, the operator will adjust the pump speed accordingly. Should the slurry line start becoming plugged, the operator may chose to temporarily suspend sluicing by shutting down the slurry pump and selecting the forward flush icon on the screen. This will automatically divert the sluice water flow from the sluicer modules to the slurry pump module and on through the slurry transfer line to the treatment facility. The operator can back flush the slurry pump by selecting the back flush icon on the screen. This action will divert the sluice water to the pump discharge. The operator must run the pump in reverse to maximize the pump suction flushing effect.

The HMI will automatically calculate the water and solids removal balance using the mass flow, sluice water flow, and tank level instrument data. The balance will be displayed on the sluicing screen and will alarm at a silo water accumulation value of 3000 gallons.

1.4 Decontamination (Decon Spray Ring Operations)

The decontamination spray ring operation screen will include graphical displays of the decon pump, one of three pumps located on the HPW pump skid. Graphic displays for each spray ring located at the sluicer module, the slurry pump module, and the EMMA will also be included with interconnecting piping from the spray rings to the HPW skid. The pump graphic will contain graphics for the basic process water flow piping from supply to pump discharge and return water. The piping graphics will include icons for the HPW automatic diverter valve, the automatic pressure control valve, and the decon pump's three automatic discharge valves. Icons and numerical output signal displays for the pump's two flow meters, and discharge pressure transmitter will be included in the piping graphics. Presence of water flow and automatic valve position status will be indicated by a change in color on the pipe or valve graphic. The pump graphics will include start/stop icons and run status will be indicated by color change of the icon. The operator changes the automatic valve status by selecting the valve icon which toggles it's position indicated by color change. A system fault status icon will be included to give the operator indication of a system up-set condition.

The operator will operate the spray ring by first ensuring the proper manual block valve located on the bridge is opened for the desired spray ring. The operator will then send HPW to the spray ring by starting the HPW decon pump. Starting this pump is done by 1) opening the decon spray ring supply valve by selecting the valve icon, 2) ensuring the diverter valve is directed to recycle and the pressure command set at zero, 3) starting the HPW pump by selecting the start icon on the pump graphic, 4) changing the diverter valve to supply position by selecting the valve icon, and 5) inputting a pressure value on the pressure control valve icon. The operator will shut down the pump by performing the above steps in reverse order.

1.5 Decontamination (ADS operation)

The Arm Deployed Sluicer (ADS) will be used to perform silo wall washing and in-silo debris washing. The ADS will also be used to assist in bulk material and heel sluicing activities. The wall and debris decontamination screen will contain graphical displays of the decon pump, one of three pumps located on the HPW pump skid. Graphic blocks for the ADS with interconnecting piping from the ADS to the HPW skid will be included. The pump graphic will contain graphics for the basic process water flow piping from supply to pump discharge and return water. The piping graphics will include icons for the HPW automatic diverter valve, the automatic pressure control valve, and the decon

pump's three automatic discharge valves. Icons and numerical output signal displays for the pump's two flow meters, and discharge pressure transmitter will be included in the piping graphics. Presence of water flow and automatic valve position status will be indicated by a change in color on the pipe or valve graphic. The pump graphics will include start/stop icons and run status will be indicated by color change of the icon. The operator changes the automatic valve status by selecting the valve icon which toggles it's position indicated by color change. A system fault status icon will be included to give the operator indication of a system upset condition.

The operator will operate the ADS by first ensuring the proper manual block valve located on the bridge is opened for the ADS water supply and the EMMA operator has opened the desired ADS nozzle automatic block valve. The operator will then send HPW to the ADS by starting the HPW decon pump. Starting this pump is done by 1) opening the decon spray ring supply valve by selecting the valve icon, 2) ensuring the diverter valve is directed to recycle and the pressure command set at zero, 3) starting the HPW pump by selecting the start icon on the pump graphic, 4) changing the diverter valve to supply position by selecting the valve icon, and 5) inputting a pressure value on the pressure control valve icon. The operator will shut down the pump by performing the above steps in reverse.

1.6 TTA Operations

Operation of the other equipment located within the TTA will be controlled from dedicated HMI display screen(s). The screen(s) will be reachable directly from one of the operation screens that is being used.

The TTA display and control will provide control of the equipment within the TTA building except for the sluicer, slurry, and decant modules.

1.7 Troubleshooting

The troubleshooting screen will be accessed by password only. The troubleshooting screen will include system programming level information, including equipment interlocks. Because of the danger of operating AWR equipment without interlocks in place, the shift supervisor or controls systems engineers will be the only project personnel with this password access. Only individual equipment items can have their interlocks removed. Removal of interlock protection for whole systems or plant wide will not be allowed.

It is highly recommended that during troubleshooting operations, that single operator operations at the HMI be changed to two operator operations. This means that two operators are monitoring and operating the equipment that is operating without interlock protection.

The interlocks that can be removed are those interlocks that are programmed within the PLC. Interlock protection that is hardwired within

the control cabinet cannot be removed. An example of a hardwired protection would be motor overload protection.

1.8 Motor Control Operation

This discussion is of the planned operation of the pump motors within the system. The Slurry pump is a variable frequency (speed) type and may require special operations.

During HMI operations, the motor can be manually started in either HMI Auto or HMI Manual. The operator can change between HMI Auto and HMI Manual without changing the running state of the motor. In HMI Auto, the motor is allowed to start automatically in response to a start command from the equipment operation sequence program. An example of a possible sequence program would be the automatic valve lineup for sluice water from a TTA tank to the sluicer and the starting of the decant pump. If the motor were in HMI Auto, the motor would start as soon as the valve lineup is completed. If the motor were in HMI Manual, the valve lineup would be completed and the sequence program would wait until the operator places the decant motor in HMI Auto or the program times out.

The motor can be stopped in either mode.

In HMI Manual mode only, a password-protected method is used to remove the pump protection interlocks. In HMI Auto, the pump protection interlocks must be in place for the motor to start. Protection cannot be removed with the motor operating.

The motor is normally operated locally with all interlock protection in place. The removal of interlock protection for local control is performed at the HMI under password-protection.

1.9 E-Stop and Q-Stop

An E-Stop push-pull switch is located on each of the sluicer, slurry, decant, and high-pressure water pump control cabinets. The E-Stop is hardwired into the local control circuits of the equipment the operating personnel will be in direct contact with. An E-Stop pushed on a sluicer control cabinet doesn't affect operations in a slurry cabinet. The condition of the E-Stop is monitored by the PLC and the E-Stop status is displayed on the HMI. The PLC backs up the E-Stop command by stopping all enclosure equipment, except Motor Operated Valves, within the enclosure. This includes the enclosure equipment that is connected to the E-Stop by hardwired and to equipment that stopped only by the PLC.

The HMI station has two controls in support of equipment operations: Master On/Off and Q-Stop switches.

The Master On/Off switch is a key lockable switch that provides a command to the PLC. The Off position will command the PLC to disregard all HMI or local field commands for equipment control. The key is removable in the Off position. The HMI will still monitor the status condition of all equipment. In the On position, the PLC performs normal equipment operation. The Master On/Off switch does not affect the RCS.

The Q-Stop switch is a push-pull type switch that when pulled out allows normal PLC operation. When pushed in (maintained), the PLC will stop all motors. The Q-Stop switch does not affect the RCS.

To recover from a Q-Stop condition, the Q-Stop switch must be pulled out and then the Master On/Off switch must be positioned to Off and then returned to On. The motors and Motor Operated Valves will not change their shutdown status. The operator may then recovery from the shutdown operation.

2.0 Local Controls

The HPU skids, HPW skids, Slurry Pump/CATS modules, Sluicer modules, and Decant Pump modules all contain local control cabinets. These cabinets are all NEMA 4 rated and contain switches and devices mounted on the front of the cabinets that are used to perform local control of the equipment systems. Each cabinet incorporates a "local/off/remote" selector switch. When this switch is in the "remote" position, the equipment may only be operated from the HMI located in the control trailers. When the switch is in the "off" position, all equipment, controlled by the PLC is removed from service. When the switch is in "local" position, the equipment can only be operated locally (interlocks and logic control is still maintained by the PLC and HMI monitoring is available). The following local control descriptions apply only to functions available when the selector switch is in the "local" mode. Each local control cabinet contains an E-Stop switch mounted conspicuously on the front of the cabinet. Depressing the E-Stop switch will stop equipment operation.

The Motor Operate Valves are powered by the UPS power system. This allows the PLC to operate the valve, if required, during a loss of site power. Also, the valve will continue to travel to its commanded position even when an E-stop is active. A valve will not be allowed to stop between states.

2.1 Sluicer Module

The sluicer module includes the following equipment that can be operated from the local control cabinet:

- Sluicer mast hoist
- Sluice water supply valve
- Cable reel

The sluicer mast hoist is operated locally from a pendant hoist switch. The hoist is moved up by switching the hoist switch to the UP position and holding it in that position. When the switch is released, it returns to

the OFF position automatically and the hoist stops. The hoist is moved down by switching and holding the hoist switch in the DOWN position. Releasing the hoist switch stops the hoist. The operator should visually verify that the hoist is moving as commanded and that cable tension is maintained at all times. The hoist operating range, upper and lower, is set with limit switches located on the hoist.

The sluice water supply valve is operated locally by setting the valve position selector switch to the desired position, OPEN or CLOSE. The operator should visually verify that the valve position indicators are in the desired position. Before placing the "local/off/remote" switch to local, the supply valve switch must be manually aligned to agree with the current valve position.

The sluicer module cable reel can only be operated locally due to safety considerations since operators must assist in cable handling activities with glovebox gloves or from inside the enclosure while the reel is operated. The reel is controlled locally by holding the spring return switch in either the OUT or IN position until the desired cable length is achieved. To stop the reel, the operator must only remove his/her hand from the switch and the switch will return to the OFF position. Before operating the cable reel, the six cables must be disconnected from the cable reel. A lockable disconnect is provided on the control cabinet to de-energized the high voltage equipment connected to these cables.

The local control panel E-stop directly stops the cable reel motor and mast hoist since these are the only two items that can be in operation when operators are inside the enclosures or gloveports. The PLC monitors the E-stop and will order a shutdown of the other equipment.

2.2 Decant Pump Module

The decant pump module includes the following equipment that can be operated from the local control cabinet:

- Pontoon and decant pump hoists
- Decant pump
- Automatic 3-way diverter valves
- Hose reel

The pontoon and decant pump hoists are operated locally by "up/off/down" hand switches mounted on the front of the local control cabinet. Each hoist is controlled from its own switch. The hoist is moved up by holding the hoist switch in the UP position. When the switch is released, it returns to the OFF position automatically and the hoist stops. The hoist is moved down by holding the hoist switch in the DOWN position. Releasing the hoist switch stops the hoist. The operator should visually verify that the hoist is moving as commanded and that cable tension is maintained at all times. The hoist is protected from travelling beyond an upper or lower travel position with limit switches.

The decant pump is operated locally by push button controls. The pump is started by pressing the DECANT PUMP START button and stopped by pressing the DECANT PUMP STOP button.

The automatic 3-way diverter valves are operated locally by setting both of the valve position selector switches to the desired positions. Positions for MOV-12-200 (202) are Supply to Silo, Supply to MOV-201 (203), and Supply to Slurry Line. Positions for MOV-12-201 (203) are Back Flush Slurry Line, Forward Flush Slurry Line, and Discharge to Tank. The operator should visually verify that the valve position indicators are in the desired position. Before placing the "local/off/remote" switch to local, the two valve switches must be manually aligned to agree with the current valve positions.

The decant pump hose reel can be remotely operated from the HMI control screens discussed in section 1.0. The reel is controlled locally by holding the spring return switch in either the RAISE or LOWER position until the desired hose length is achieved. To stop the reel, the operator must only remove his/her hand from the switch and the switch will return to the OFF position.

The local control panel E-stop directly stops the cable reel motor, decant pump, and the two hoists since these are the only three items that can be in operation when operators are inside the enclosures or gloveports.

2.3 Slurry Pump/CAT Module

The slurry pump module includes the following equipment that can be operated from the local control cabinet:

- Slurry pump variable frequency drive
- Automatic 3-way diverter valves
- Pump lift table drive
- CAT hose bundle reel
- Enclosure heater

The slurry pump variable frequency drive is operated locally by using the push button control panel on the front of the variable frequency drive. The control panel allows motor startup, direction and speed to be set, and motor shutdown. The variable frequency drive is located inside a heated and air conditioned cabinet. To operate the variable frequency drive, the cabinet door must be open. A physical barrier for operator protection is provided between the control panel and the high voltage components.

The two diverter valves are operated locally by operating the valve selector switch for the desired valve. Positions for MOV-11-300 (301,302) are Pump Back Flush, Flush to TTA, and Normal Pumping., Positions for MOV-11-303 (304,305) Flush Supply to Pump Can, Flush Supply to MOV 300, and Pump Recirc. Position for MOV-11-306 (307,308) is any

position from Open to Close. Before placing the "local/off/remote" switch to local, the two valve switches must be manually aligned to agree with the current valve positions.

The slurry pump lift table is locally controlled by switching the "Up/Off/Down" switch to the desired direction and holding the switch until the lift table has reached the desired position.

The CAT hose/cable bundle can only be operated locally due to safety considerations since operators must assist in hose and cable bundle handling activities inside the enclosure while the reel is operated. The reel is controlled locally by switching the "Out/Off/In" switch to the desired direction until the hose/cable bundle has reached the desired length.

The local control panel E-stop directly stops the hose/cable reel motor and the lift table since these are the only two items that can be in operation when operators are inside the enclosures or gloveports.

Before operating the cable reel, the motor cable connector must be disconnected from the cable reel before the cable reel may be operated. A lockable disconnect is provided on the variable frequency drive control cabinet to de-energized the high voltage equipment connected to this cable.

The enclosure heater is operated locally by a heater mounted thermostat control. The thermostat is adjusted from a temperature selector mounted on the heater inside the enclosure.

2.4 High Pressure Water Pump Skid

When the "Local/Off/Remote" switch is in the "Local" position and the pumps are not running, the recycle/supply diverter valves will default to the recycle position. The HPW pump skid contains the following equipment that can be operated from the local control cabinet:

- SREE cutting jet supply pump and associated air operated valves
- Jet pump motive water supply pump and associated air operated valves
- Decon water supply pump and associated air operated valves
- Lube water collection sump pump
- Leak collection pan sump pump
- Enclosure heater and vent fan

The local control cabinet has a system fault light on the front of the control cabinet which gives indication of a system upset condition. An E-stop switch is also located on the front of the local control cabinet, which will de-energize the three pump's motors when pushed in. Before operating any of the HPW pumps locally, the operator must verify that air pressure and process water supply and return are available and functional.

Before locally operating the SREE cutting jet HPW supply pump, the operator must ensure that the manual pressure control valve is in the fully open position. The SREE cutting jet supply pump is started by moving the SREE pump 3-way switch to the pump on-recycle position. To send water to the SREE cutting jets the 3-way switch is moved to the pump on-supply position. The operator then manually closes the manual pressure control valve until the desired pressure is reached as determined by reading the local discharge pressure gauge. The pump is shut down in reverse order of the above steps.

Before locally operating the jet pump motive HPW supply pump, the operator must ensure that the manual pressure control valve is in the fully open position. The jet pump supply pump is started by moving the jet pump 3-way switch to the pump on-recycle position. To send water to the jet pump motive jets, the 3-way switch is moved to the pump on-supply position. The operator then manually closes the manual pressure control valve until the desired pressure is reached as determined by reading the local discharge pressure gauge. The pump is shut down in reverse order of the above steps.

Before operating the decon HPW supply pump, the operator must ensure that the manual pressure control valve is in the fully open position and the desired discharge valve is opened. To open the desired discharge valve, the operator moves the discharge valve selector switch from the closed position to either the waste conveyance line flush, the SREE fan jet, or the decon spray ring position. When using the decon spray rings, the operator must also ensure that the proper manual valve is open for the desired spray ring or the ADS. The decon HPW supply pump is started by moving the decon HPW pump 3-way switch to the pump on-recycle position. To send water to the HPW service points, the 3-way switch is moved to the pump on-supply position. The operator then manually closes the manual pressure control valve until the desired pressure is reached as determined by reading the local discharge pressure gauge. The pump is shut down in reverse order of the above steps.

The lube water sump pump is operated automatically by local level switches.

2.5 Hydraulic Power Unit Skid

The HPU skid contains the following equipment that can be operated from the local control cabinet:

- The hydraulic pump
- The flow control valve
- The oil reservoir heater
- The oil cooler and enclosure vent fan

Before operating the HPU locally, the operator should ensure that the flow adjustment setting is at zero flow. The hydraulic pump can be started by

switching the pump "run/stop" switch to the "run" position. The operator adjusts the flow by entering the desired flow value in the flow control adjustment device. The control cabinet has a system fault light on the front of the control cabinet which gives indication of a system upset condition. An E-stop switch, also located on the front of the local control cabinet, will stop all HPU motors when pushed in. The oil cooler and enclosure vent fan are controlled by locally mounted and adjustable thermostats.

3.0 Equipment Descriptions

The following sections describe the main equipment components within each equipment module.

3.1 Central Control Systems

The central control system for both FSMS and AWR operations is based around the Siemens Programmable Logic Controller (PLC). Operator interface is provided by a graphics HMI. The HMI is in a redundant configuration. Each equipment module (sluicer, slurry, decant, HPW) has an ET200M I/O control and data node. The node consists of Profibus communication module connected up to analog and digital I/O modules. Communication between the PLC and the ET200M nodes is via the Profibus network.

All components of the control system (PLC, HMI, communication devices, ET200M nodes) are powered from the site wide Uninterruptible Power Supply (UPS)

Programmable Logic Controller

The PLC is a Siemens bundled PCS7 system. A bundled system provides a powerful system already configured and assembled.

The PCS7 system consists of a UR2 9-slot backplane rack. The rack provides for disturbed power and communications between the rack's plug in modules.

The Siemens power supply occupies the first two rack slots. The power supply uses 120 vac, single-phase power to produce the 24 vdc, 10 amp output. The power supply contains two lithium AA batteries for power backup to keep the PLC RAM memory intact on a complete lost of power.

The PLC itself is a Siemens CPU S7416-2DP module. The CPU is equipped with 1600 Kbytes of run program/data memory. This amount of provides the necessary 25% excess memory required per the design specifications. The CPU contains 2000 Kbytes of load memory that contains the operating program. The CPU supports 2048 Function Blocks, 2048 Functions, and 4095 Data Blocks. CPU execution time is 0.08 µs for bit, word, and fixed-point addition operations and 0.48 µs for

floating-point addition. The CPU supports 511 counters and timers and 2047 8-bit retentive memories. The CPU supports both 187.5 kbit/s Multi-point interface (MPI) and 12 Mbit/s Profibus communication networks. Total I/O channels supported by the CPU is 65536 digital I/O and 4096 analog I/O. The CPU module requires two slots.

A Siemens Ethernet communications processor, CP 443-1 TCP, is installed in slot 5 of the UR2 rack. The CP supports Ethernet communications between the CPU and the HMI and Programming Station computers. The CP handles only the 10 Mbit/s Ethernet communication speeds and not the fast 100Mbit/s speeds.

A Siemens S7-421 digital input module in slot 6 provides 32 point, 24 vdc, isolated signal inputs. The input module supports digital signals from the joystick controls, sluicer mast control, Master On/Off and Soft-Stop switches. Eight signal inputs are reserved for communications with the EMMA PLC system.

A Siemens S7-422 digital output module in slot 7 provides 16 point, relay, isolated signal inputs. The module reserves eight digital signals for communications with the EMMA PLC system.

HMI Computers

Two Dell XPS mini-tower computers operate in a redundant mode to provide HMI support for the PLC. The Dell computers are equipped with 600 MHz Pentium III processors with 256 Mbyte of RAM, 30 Gbyte hard drive, CD-RW module, 100 Mbyte ZIP drive, 16 Mbyte graphics card driving a 21 inch color monitor. The computers have the NT 4.0 operating system and virus protection software. The computers are equipped with the Siemens PCI Ethernet card for networking to the PLC. The computers are selected to provide fast command input and graphics update speed. The large hard drive and the CD-RW and ZIP drives provide the means to storage operating trending data as required by the design specification.

Each computer is loaded with the PCS7 operating station software with server support and 64K tag runtime license. The computers are also equipped with sequence visualization software and data archiving software. The sequence visualization is a graphics package to allow the rapid determination of a failure in a sequence program. The data archiving package for the collection of operating data and storing the data during operations.

The computers are loaded with the Siemens WINCC redundancy software. This software will keep both computers in synch with operating data. If one computer should fail and later return on line, the operating computer will update failed computer with all operating information collected during the computer's downtime.

One or both computers can be used to monitor and control equipment with the HMI. This allows the operator(s) to monitor and control two different operations at the same time.

HMI Controls

Controls located at the HMI station includes a digital two-speed joystick with a deadman switch, joystick speed select control, sluicer mast control, Master On/Off keylock switch, and the Q-Stop push-pull switch.

The sluicer nozzle control joystick is a two degree-of-freedom two-speed digital joystick. This means that in any direction the joystick commands only two speeds. The operator determines the faster sluicer nozzle speed from a list of predefined speeds at the HMI sluicer graphic icon. The slower joystick speed is one-half of the fast speed. A manual toggle switch (normal/slow) located near the joystick will reduce the joystick speeds by a factor of four in the slow position. The joystick is equipped with a deadman switch which the operator must hold to cause the sluicer nozzle to follow the joystick commands. The joystick is spring returned to center. During TTA waste removal operations, there will be two sluicers on the TTA tanks. The operator selects which sluicer nozzle the joystick will control by using the HMI sluicer graphic screens to select the active sluicer nozzle.

The sluicer mast height is controlled by a toggle switch located near the joystick. The toggle switch is spring-returned to center that causes the sluicer mast to stop and hold at its current position. The other switch positions are Up and Down and controls the direction of the sluicer mast. The joystick deadman must be held closed by the operator before sluicer mast switch will move the sluicer mast. This method requires two hands to move the sluicer mast and will prevent unwanted motion.

The Master On/Off switch is a keylock switch located near the HMI. When the switch is Off, the PLC is commanded not to start any motor driven equipment. When the switch is On, the PLC will accept all operator commands. The key can be removed from the switch when the switch is in the Off position.

The soft-stop switch is a push-pull type of switch. When the soft-stop switch is pulled, normal operation of the equipment is allowable. When the soft-stop switch is pushed, the PLC is commanded to stop all motor driven pumps. After the soft-stop switch is pushed, the soft-stop switch must be pulled out and the Master On/Off switch must be turned to Off position and then to the ON position. This sequence of operations commands the PLC to begin equipment operations from the HMI or locally if desired.

Ethernet Communications

All Ethernet devices are connected to a 3Com SuperStack Baseline Hub. The Ethernet devices include the PLC, the two HMI computers, the RCS HMI computer, Programming Station computer, and a printer. The Hub is equipped with 12 RJ-45 10BASE-T ports. A Hub port is connected to the computers' or PLC's Ethernet card with a color-coded twisted-pair cable connected to a RJ-45 to AUI transceiver (Siemens network connections is with AUI interface). The 3Com Hub is also equipped with an internal fiber optic transceiver module. The fiber optic transceiver connects the RCS HMI with the RCS local HMI located at the RCS skid. The two RCS HMIs operate in redundant mode operation. With this link, the control PLC can communicate with the RCS PLC.

Programming Station Computer

The programming station computer is identical to the HMI computers except the color monitor is 19 inches. The computer is connected to the PLC with the Ethernet connection. Because of the Profibus network, the programming station will be able to monitor not only the control PLC but also the RCS PLC and all the ET200M data and control nodes. The programming station includes a runtime operating station license and can be used as a third HMI if desired.

The programming computer is loaded with the Siemens PCS7 ES Toolset. The Toolset includes the programming languages: STEP7 Basic Programming package, the SCL (Standard Control Language) package, CFC (Continuous Function Chart) package, SFC (Sequential Function Chart) package. Along with these packages, the programming computer contains the Basic Block, Technology Block, Field Device Block, and Driver Block libraries. Other packages within the toolset include the import/export assistant and DOCPRO package. The DOCPRO package will combine all programming files on the programming station and produce a complete documentation package with diagrams and cross-references. The S7PLC simulation package is included to allow testing or simulation of I/O hardware before the hardware becomes available.

The programming computer is also loaded with the Siemens PCS7 OS Engineering and Configuration Toolset. This toolset creates the HMI as the PLC programming is performed. Changes or additions to the PLC program are reflected on the HMI graphical display.

RCS HMI

The RCS HMI is a redundant HMI for the local HMI located at the RCS skid. The HMI computer is identical to the HMI computers except the color monitor is 19 inches.

Profibus Network

The PLC communicates with the ET200M data and control nodes located on the major equipment modules over the Profibus network. The Profibus network travels from the control trailer to the silo bridge (sluicer and slurry), to the HPW pump skid, to the electrical power panel, and into the TTA building (sampler valve box, distribution valve box, tank 30, tanks 1A, 1B, 2A, and 2B, make-up water system, and FSM diverter box), and then back to the control trailer. The Profibus network outside the TTA building is fiber optic. Inside the TTA building, the network is copper wire.

The Profibus network is in a ring configuration. The ring allows a break in the network at any point and all network traffic will be unaffected. The PLC Profibus port is connected to two optical link modules that connect to each end of the field fiber optic network. Each optical link module is powered by its own separate power supply.

ET200M Data and Control Node

Each sluicer, slurry, decant, and HPW module includes a Siemens ET200M data and control node. The ET200M consists of a backplane for power and communication. The first module on the backplane is a 5 amp 24 Vdc power supply. The power supply is powered by the 120 Vac UPS. The second module is the Siemens IM153 module which performs the network communications with the PLC and collects the data from up to eight S7-300 type I/O modules.

The ET200M allows the change out of an I/O module during operations and without powering the system down.

The S7-300 I/O modules include digital input and output (DC and AC voltages) modules and analog input and output (voltage and current) modules. An absolute encoder module is also used for the sluicer module. Field terminations to the I/O modules are via a quick plug to the I/O module connection.

The spare I/O on an ET200M node is at least 25% of the total type of the I/O located at that ET200M node.

3.2 Sluicer Modules (SLC-11-203, -204, -205)

The Sluicer Modules contain the following devices that interact with local and remote control systems:

- Sluice Water Supply Valves (MOV-11-201, -202, -203)
- Sluicer Pitch Drives (PTH-11-201, -202, -203)
- Sluicer Yaw Drives (YAW-11-201, -202, -203)
- Mast Hoists (CRH-11-201, -202, -203)

- Mast Hoist High/Low Position Switches (ZSH/L CRH-11-201, -202, -203)
- Mast Hoist High-High Position Switches (ZSHH CRH-11-201, -202, -203)
- Cable Reels (CBR-11-201, -202, -203)
- Sluicer Water Pressure Indicating Transmitters (PIT SLC-11-203, -204, -205)
- Local E-stop (XX-SLC-11-203, -204,-205)

Sluice Water Supply Valves

The sluice water supply valves are electrically actuated, 2-way ball valves. The actuators are powered by 120 vac, single-phase UPS power. The valves control the flow of sluice water to the sluicer nozzle. When operating the sluicer module remotely, the valves are controlled from the HMI operator's screen. When operating locally the valves are operated by switching "open/close" hand switch (HC-MOV-11-201, -202, and 203) to the desired position.

Sluice Water Supply Valve Interlocks:

- Close sluice water supply valves (MOV-11-201, -202, -203) when any line flushing modes are selected from the HMI screen.
- Close when either remote or local E-stop is initiated.
- Loss of site power, the sluice water supply valve will be closed.
- Loss of the decant pump supplying sluice water; signal from (PMP-12-200, -201).
- RCS fault; signal from RCS

Sluicer Pitch Drives

The sluicer pitch drive moves the pitch joint to control the sluicer nozzle vertical angle. The drive motor is a PWM servo motor. The servo drive amplifier is powered by 120 vac, single-phase power. The pitch drive can only be operated remotely at the HMI. The drive is a servo drive with closed loop position feedback from an absolute encoder mounted at the pitch joint. The nozzle's pitch position is displayed on HMI screens discussed in section 1.1, above. It has the ability of moving the joint at speeds from 0.1 to 5 degrees/sec. Position limits are password controlled by the HMI operator.

Sluicer Pitch Drive Interlocks:

- Mast elevation > -10 ft
- Local control switch in "Hand" position
- De-energize with either local or remote E-stop
- Operating range of the nozzle's pitch drive is limited by user assigned position limits; values from HMI
- Local E-stop; signal from local E-stop (XX-SLC-11-203,-204-205)
- The joystick deadman; signal from HMI station
- Soft-Stop; signal from HMI station
- Master On/OFF; signal from HMI station

000577

Sluicer Yaw Drives

The sluicer yaw drive moves the pitch joint to control the sluicer nozzle horizontal angle. The drive motor is a PWM servo motor. The servo drive amplifier is powered by 120 vac, single-phase power. The yaw drive can only be operated remotely at the HMI. The drive is a servo drive with closed loop position feedback from an absolute encoder mounted at the yaw joint. The nozzle's yaw position is displayed on HMI screens discussed in Section 1.1. It has the ability of moving the joint at speeds from 0.1 to 5 degrees/sec. Position limits are password controlled by the HMI operator.

Sluicer Yaw Drive Interlocks:

- Mast elevation > -10 ft
- Local control switch in "Hand" position
- De-energize with either local or remote E-stop
- Operating range of the nozzle's yaw drive is limited by user assigned position limits; values from HMI
- Local E-stop; signal from local E-stop (XX-SLC-11-203,-204-205)
- The joystick deadman; signal from HMI station
- Soft-Stop; signal from HMI station
- Master On/OFF; signal from HMI station

Mast Hoists

The mast hoists are 2-ton hoists powered by 480 volt, 3 phase AC. They support the weight of the sluicer mast and control the vertical mast position. The hoist has 2 switches. The high/low switch (ZSH/L-CRH-11-201, -202, -203) sets the upper and lower travel limits for the hoist. The high-high switch (ZSHH-CRH-201, -202, -203) prevents the hoist from pulling the hook too far up in the event the high/low switch malfunctions or is set improperly. The hoist can be operated remotely from the HMI station discussed in Section 1.1. The hoists are locally controlled by hand pendant switches (HS-CRH-11-201, -202, -203) mounted to the local control cabinet. The pendant can be carried to any location around the sluicer enclosure.

Mast Hoist Operational Interlocks:

- De-energize with either local or remote E-stop
- The high/high limit switch is wired directly into the hoist controls. There is no HMI display for this limit switch.
- The high/low limit switches are also wired directly to the hoist controls but the PLC does monitor the condition of the limit switches to provide HMI feedback.
- Local E-stop; signal from local E-stop (XX-SLC-11-203,-204-205)
- Soft-Stop; signal from HMI station
- Master On/OFF; signal from HMI station

000578

Cable Reels (CBR-11-201, –202, -203)

Due to safety issues of having personnel handling the cable from inside the module or from gloves while the reels are in operation, the cable reels are only operated locally. The cable reels are driven by reversible, single speed, AC drive motors. The reels are operated by "out/off/in" hand switch (HS-CBR-11-201, -202, -203) located on the front of the local control cabinets.

Cable Reel Operational Interlocks:
- De-energize with either local or remote E-stop
- Local E-stop; signal from local E-stop (XX-SLC-11-203,-204-205)

Sluicer Water Pressure Indicating Transmitters (PIT SLC-11-203, -204, -205)

The pressure transmitters provide sluice nozzle supply pressure feedback 4-20 ma signal for the HMI displays.

3.3 Decant Pump Modules (DEC-12-200, -201)

The Decant Pump Modules contain the following devices that interact with local and remote control systems:
- Pontoon and Pump Hoists (CRH-12-200, -201, -202, -203)
- Pontoon/Pump Hoists High/Low Position Switches (ZSH/L CRH-12-200, -201, -202, -203)
- Hose Reels (HSR-12-200, -201)
- Flow Control Valves (MOV-12-200, -201, -202, -203)
- Decant Pumps (PMP-12-200, -201)
- Decant Pumps Pressure Indicating Transmitters (PIT PMP-12-200, -201)
- Decant Flow Indicating Transmitters (FET PMP-12-200, -201)
- Local E-stop (XX-DEC-12-200, -201)

Flow Control Valves (MOV-12-200, -201, -202, -203)

The decant pump flow control valves control flow of sluice water out of the tank and slurry into the tank. The valves are automatic diverter valves electrically actuated, 3-way ball valves. The actuators are powered by 120 vac, UPS single-phase power. When operating the decant pump module remotely, the valves are controlled from the HMI screens as discussed in section 1.0. When operating locally (manually) the valves are operated by switching 3-position hand switches (HS-MOV-12-200, -201, -202, and 203) to the desired position. Valve MOV-12-201 and -203 are interlocked with slurry pump positive rotation operation to ensure the slurry pump cannot discharge slurry to the sluice (flush) water line. MOV-12-200 (202) normal operation "Supply to Silo" is to supply decant water to the silo or to MOV-201 (203) "Supply to MOV-201 (203) for flushing. A third position is connecting the slurry line to the silo sluice supply line and is a forbidden operation "Supply to Slurry Line". MOV-12-

201 (203) normal mode of operation "Discharge to Tank" is to direct slurry from the silo into the TTA tank. MOV-201 (-203) can direct decant water from MOV-200 (-201) to back flush "Back Flush Slurry Line" the slurry line to the slurry enclosure or direct decant water from MOV-200 (-203) to forward flush "Forward Flush Slurry Line" the slurry line to the TTA tank.

Flow Control Valves Interlocks:

- MOV-12-200 (202) cannot be reposition when the decant pump (PMP-12-200, -201) is operating
- MOV-12-201 (203) cannot be reposition when the slurry pump (PMP-11-300, -301, and –302) is operating
- MOV-12-200 (202) and MOV-12-201 (203) cannot be position in the forbidden position if the slurry pump (PMP-11-300, -301, and –302) is operating.
- RCS fault; signal from RCS

Pontoon and Pump Hoists (CRH-12-200, -201, -202, -203)

The pontoon and pump hoists are 5-ton hoists powered by 480 volt, 3-phase single speed motors. They are used to lower and raise the pontoon platform and the decant pump independently into and out of the tanks. The high/low switches (ZSH/L-CRH-12-200, -201, -202, -203) set the upper and lower travel limits for the hoists. The hoists can be operated remotely from the HMI as discussed in Section 1.0. The hoists are locally controlled by hand switches (HS-CRH-12-200, -201, -202, -203) mounted on individual pendants. The pendants can be carried to any point around the decant module.

Pontoon/Pump Hoists Operational Interlocks:

- De-energize with either local or remote E-stop
- Hoist is limited to operating range signal by ZSH/L-CRH-12-200, -201, -202, -203
- Local E-stop; signal from XX-DEC-12-200, -201
- Soft-Stop; signal from HMI station
- Master On/OFF; signal from HMI station

Hose Reels (HSR-12-200, -201)

The hose reels pay out decant pump discharge hose as the pump is deployed into the TTA tanks and take up hose slack hose as the pump/pontoon raises with TTA tank contents level. The reels are operated remotely from the HMI screens described in Section 1.0. The reels are operated locally by hand switches (HS-HSR-12-200, -201) located on the front of the local control cabinets.

Hose Reels Operational Interlocks:

- De-energize with either local or E-stop
- Local E-stop; signal from XX-DEC-12-200, -201

Decant Pumps (PMP-12-200, -201)

The decant pumps are centrifugal pumps driven by 75 hp, 480 vac 3-phase single speed drives operating at 3550 rpm. The pumps are capable of supplying sluice water at 300 gpm as indicated by sluice water flow transmitter (FET-PMP-12-200, -201) and 150 psig as indicated by sluice water pressure transmitter (PIT-PMP-12-200, -201). The pump is controlled locally by START and STOP pushbuttons mounted on local control cabinets. The decant pumps are remotely controlled from the HMI as discussed in section 1.0. The motor starter is equipped with a lockable disconnect to remove motor power when the pump discharge hose is being reposition.

Pump Operation Interlocks:

- High TTA tank level (FWENC to supply level); signal from level transmitter XXXXXXXX
- Low TTA tank level (FWENC to supply level); signal from level transmitter XXXXXXXX
- Low pump flow rate; set point = 200 gpm; signal from decant pump flow meter (FT-PMP-12-200 and -201), delayed for 15 seconds during pump start
- Low pump discharge pressure; set point = 100 psig; signal from pressure transmitter (PIT-PMP-12-200 and -201), delayed for 15 seconds during pump start
- Leak detected; signal from (FWENC to supply XXXXXXXXXXX)
- RCS fault; signal from (FWENC to supply XXXXXXXXXXX)
- Local E-stop; signal from local E-stop (XX-DEC-12-200 and -201)
- Soft E-stop; signal from the HMI
- Local E-stop; signal from XX-DEC-12-200, -201
- Soft-Stop; signal from HMI station
- Master On/OFF; signal from HMI station
- The pump is not allowed to start if MOV-12-200 (202) is in motion; by HMI station
- RCS fault; signal from RCS

Decant Pumps Pressure Indicating Transmitters (PIT PMP-12-200, -201)The pressure transmitters operates off 24 vdc power and provides 4-20 ma decant pump discharge pressure signals for the HMI displays. Low and high-pressure alarms are provided to the HMI. The low-pressure alarm has a time delay of 15 seconds after motor start.

Decant Flow Indicating Transmitters (FET PMP-12-200, -201)

The flow transmitters operates off 24 vdc power and provides 4-20 ma decant pump discharge flow signals for the HMI displays. Low and high-flow alarms are provided to the HMI. The low-flow alarm has a time delay of 15 seconds after motor start.

3.4 Slurry Pump/CAT Modules (SLR-11-200, -201, and -202)

The Slurry Pump/CAT Modules contain the following devices that interact with local and remote control systems:

- Slurry pumps (PMP-11-300, -301, and –302)
- Lift tables (LFT-11-300, -301, and –302)
- Hose bundle reels (CBR-11-300, and –301)
- Automatic control valves (MOV-11-306, 307, 308)
- Slurry line automatic diverter valves (MOV-11-300, -301, -302)
- Sluice (flush) water automatic diverter valves (MOV-11-303, -304, -305)
- Slurry mass flow meter (FET-SLR-11-200, -201, -202)
- Slurry pressure transmitter (PIT-SLR-11-200, -201, -202)
- Lift table level transmitter (LT-LFT-300, -301, -302)
- Slurry pump inlet level transmitter (LT-PMP-300, -301, -302)
- Slurry pump inlet solids contact switch (YS-PMP-300, -301, -302)
- Local E-stop (XX-SLR-11-200, -201, -202)

Slurry pumps (PMP-11-300, -301, and -302)

The slurry pumps are progressive cavity pumps driven by 50hp 480 vac, 3 phase power variable speed drives. The pumps operate in a range of 0gpm to 350gpm as indicated by Slurry mass flow meter (FET-SLR-11-200, -201, -202) and 0 to 150 psig as indicated by Slurry pressure transmitter (PIT-SLR-11-200, -201, -202). Locally the pump is controlled by a local control cabinet mounted keypad controller (HS-PMP- 11-300, -301, -302) mounted on the variable speed drive. The slurry pumps are remotely controlled from the HMI features discussed in Section 1.0.

Pump Operation Interlocks:

- -Low make up water supply pressure; set point=10 psig, signal from PIT-PMP-12-200 (201)
- Low slurry pump inlet level; set point= 6"; signal from slurry pump inlet level transmitter (LT-PMP-300, -301, -302)
- Low slurry discharge flow rate; set point=150 gpm; signal from slurry mass flow meter (FET-SLR-11-200, -201, -202), delayed for 15 seconds during pump start
- High slurry discharge pressure; set point=15 psig; signal from slurry pressure transmitter (PIT-SLR-11-200, -201, -202)
- Low slurry discharge pressure; set point=50 psig signal from slurry pressure transmitter (PIT-SLR-11-200, -201, -202), delayed for 15 seconds during pump start
- Sluice water line protection; position "Pump Back Flush" signal from (ZS-MOV-11-300, -301, and -302), slurry line automatic diverter valves (MOV-11-300, -301, -302) directed to send slurry into sluice water line
- Leak detected; signal from (XXXXXXXXXXX)
- RCS fault; signal from RCS.

000582

- Local E-stop; signal from local E-stop (XX-SLR-11-200, -201, -202)
- Soft-S-stop; signal from the HMI station
- Master On/Off: signal from HMI station

Lift tables (LFT-11-300, -301, and –302)

The slurry pump lift tables are driven by reversible, single speed, 480 vac, 3-phase drive motors. These motors are locally controlled by a hand switches (HS-LFT-11-300, 301, and 302) mounted on the front of the local control cabinet. The elevation of the lift tables is tracked by the lift table level transmitters (LT-LFT-11-300, 301, and 302). The value of the elevation is displayed remotely on the HMI screens discussed in Section 1.1.

Lift Table Operation Interlocks:

- Pump inlet solids contact; signal from slurry pump inlet solids contact switch (YS-PMP-300, -301, -302)
- High level position; set point=16 ft.; signal from lift table level transmitter (LT-LFT-300, -301, -302)
- Low level position; set point=1 ft; signal from lift table level transmitter (LT-LFT-300, -301, -302)
- Local E-stop; signal from local E-stop (XX-SLR-11-200, -201, -202)
- Soft S-stop; signal from the HMI

Hose bundle reels (CBR-11-300, and -301)

Due to safety issues of having personnel handling the hose bundle from inside the module while the hose bundle reels are in operation, the hose bundle reel is only operated locally. The hose bundle reels are driven by reversible, single speed, 480 vac, 3-phase drive motors. The reels are operated by a "run/stop" hand switch (HS-CBR-11-300, -301, and 302) located on the front of the local control cabinets.

Hose Bundle Reel Operational Interlocks:

- Local E-stop; signal from local E-stop (XX-SLR-11-200, -201, -202)

Automatic control valves (MOV-11-306, 307, 308)

The automatic control valves, powered by a single phase 120 vac UPS power, are used to inject sluice water into the slurry discharge line exiting the module in order to keep the slurry solids concentration at 20% by weight or less. When operating the slurry pump remotely, the valves are close loop controlled by the central control PLC using signals from the slurry mass flow meter (FET-SLR-11-200, -201, -202). The PLC controls the valve automatically, opening the valve at 20% solids or higher and closes the valve at 15% solids or lower. The valve operation is interlocked to operate only when the slurry pump is operating. When operating locally (manually) the valves are operated by switching "open/close" hand switch (HS-MOV-11-306, -307, and 308) to the desired

position. Valve position is provided by 4-20 ma signal to the HMI. Fully closed and fully open valve positions are provided by limit switches.

Slurry line automatic diverter valves (MOV-11-300, -301, -302)

The slurry line automatic diverter valves are electrically actuated, 3-way ball valves. The actuators are powered by 120 vac, single-phase UPS power. They direct the slurry flow to the slurry transfer line when in position "Normal Pumping" sensed by valve position switches (ZS-MOV-11-300A/B/C/D, -301A/B/C/D, and 302A/B/C/D). When in position "Pump Back Flush", the valves allow sluice water to be directed to the slurry pump discharge for back flushing purposes. When in position "Flush to TTA", the valves allow sluice water to be directed though the slurry transfer line. The valves are interlocked with pump positive rotation operation to ensure the pump cannot discharge slurry to the sluice (flush) water line. When operating the slurry pump remotely, the valves are automatically positioned by PLC from HMI commands as described in Section 1.1. When operated manually from the local control cabinet, the operator moves the valve position by moving the valve position selector switch (HS MOV-11-300, -301, and -302) to the desired valve position.

Sluice (flush) water automatic diverter valves (MOV-11-303, -304, -305)

The sluice (flush) water automatic diverter valves are electrically actuated, 3-way ball valves. The actuators are powered by 120 vac, single-phase UPS power. They direct the sluice water flow to the slurry pump inlet screen when in position "Flush Supply to Pump Can" sensed by valve position switches (ZS-MOV-11-303A/B/C/D, -304A/B/C/D, and 305A/B/C/D). When in position "Flush Supply to MOV-11-300 (-301, -302), the valves sluice (flush) water to the slurry transfer line for forward flushing purposes. When operating the slurry pump remotely, the valves are automatically positioned by PLC from HMI commands as described in Section 1.0. When operated manually from the local control cabinet, the operator moves the valve position by moving the valve position selector switch (HS MOV-11-303, -304, and -305) to the desired valve position.

Slurry mass flow meter (FET-SLR-11-200, -201, -202)

The slurry mass flow meter is a corriolis type straight through dual tube flow meter. The meter operates off 120 vac power and outputs a signal in Profibus format. This signal is used by the PLC when operating the slurry pump remotely to control the % solids of slurry by closed loop control of the automatic control valves (MOV-11-306, 307, 308). The control range is 15% to 20% by weight of solids as discussed in Section 1.1.

Slurry pressure transmitter (PIT-SLR-11-200, -201, -202)

The slurry pressure transmitter operates off 24 vdc power and outputs a 4-20 ma analog signal. This signal is used to evaluate the slurry transfer process as well as prevent the slurry pump from being run dry. The slurry

pump is interlocked to shut down when the output signal reaches 150 psig or more and shut down when the signal reaches 50 psi or less 15 seconds after the pump start command is received by the PLC.

Lift table level transmitter (LT-LFT-300, -301, -302)

The lift table level transmitter operates off 24 vdc power and outputs a 4-20 ma analog signal. This signal is used to provide the operator with data on the lift table elevation position relative to the floor of the slurry pump enclosure. The lift table drive is interlocked to shut down when the output signal reaches 16 ft or more and shut down when the signal reaches 1 ft or less.

Slurry pump inlet level transmitter (LT-PMP-300, -301, -302)

The slurry pump inlet ultrasonic level transmitter operates off 24 vdc power and outputs a 4-20 ma analog signal. This signal is used to provide the operator with data on the slurry pool depth relative to pump suction. The data is used to prevent the slurry pump from being run dry. The level data is also used to evaluate the material balance in the heel surge tank during silo heel retrieval. The slurry pump drive is interlocked to shut down when the output signal reaches 6 in or less.

Slurry pump inlet solids contact switch (YS-PMP-300, -301, -302)

The slurry pump inlet contact switch operates off 24 vdc power and provides digital output signal. The switch is used to detect when the slurry pump inlet screen contact the solid material in the silos and prevents inlet screen damage from driving the pump into the solid material. The lift table drive is interlocked to stop when the switch is made by contacting solid material.

3.5 High Pressure Water Pump Skids (SKD-11-250 and SKD-11-251)

The High Pressure Water (HPW) Pump skids contains the following devices that interact with local and remote control systems:

- Lubrication water sump pump (PMP-11-252, and 258)
- Lubrication water sump level switch (LS SMP-11-251 and -257)
- Collection pan sump pump (PMP-11-253, and 259)
- Collection pan sump level switch (LSH SMP-11-250 and -256)
- Local E-stop (XX-PMP-11-250 and -251)
- Soft S-stop from the HMI

SREE Cutting Jet Pump Subsystem

- SREE cutting jet HPW supply pump (PMP-11-250 and -256)
- Supply/Recycle automatic diverter valves (AOV-11-233 and -244)
- Automatic pressure control valve (AOV-11-231 and -243)
- Differential flow meters (FE PMP-11-250A&B and -256A&B)
- Discharge pressure transmitters (PT PMP-11-250 and -256)

- Discharge pressure controller (PY PMP-11-250 and -256)

Jet Pump HPW Supply Pump Subsystem

- Jet pump HPW supply pump (PMP-11-251 and -257)
- Supply/Recycle automatic diverter valves for PMP-11-251 and -257, (AOV-11-233 and -244)
- Automatic pressure control valve for PMP-11-251 and -257, (AOV-11-234 and -245)
- Differential flow meters (FE PMP-11-251A&B and -257A&B)
- Discharge pressure transmitters (PT PMP-11-251 and -257)
- Discharge pressure controller (PY PMP-11-251 and -257)

Decon Pump HPW Supply Pump Subsystem

- Decon HPW supply pump (PMP-11-254 and -260)
- Supply/Recycle automatic diverter valves for PMP-11-254 and -260, (AOV-11-250 and -238)
- Automatic pressure control valve for PMP-11-254 and -260 (AOV-11-239 and -251)
- Differential flow meters (FE PMP-11-254A&B and -260A&B)
- Discharge pressure transmitters (PT PMP-11-254 and -260)
- Discharge pressure controller (PY PMP-11-254 and -260)

<u>Lubrication water sump pump (PMP-11-252, and 258) and lubrication water sump level switch (LS SMP-11-251 and -257)</u>

The lubrication water sump pump is an air operated diaphragm pump which returns the HPW lubrication water back to the process water recycle loop. The pump is located in a small collection tank. The pump turns on automatically when the upper level switch (LS SMP-11-251 and -257) is energized and opens the solenoid operated air valve controlling the compressed air that drives the pump. When the sump level reaches the lower limit, the limit switch de-energizes the solenoid and tuns off the pump. The level switch and the solenoid are both operated off 24 vdc power. The sump pump operates in this manner for both local and remote HPW pump skid operation.

<u>Collection pan sump pump (PMP-11-253, and 259) and Collection pan sump level switch (LSH SMP-11-250,and 256)</u>

The collection pan sump pump is an air operated diaphragm pump which returns the any leakage water back to the process water recycle loop. The pump is located in the skid collection pan sump. The high level switch (LSH SMP-11-250, and 256) senses the presence of liquid in the sump in case a HPW pump or piping develops a leak. If liquid is detected, the sensor sends a digital fault signal. This fault signal is sent to the PLC which then is displayed on the HMI screens discussed in Section 1.0. The fault signal is also displayed locally on the front of the local control cabinet. The compressed air driving the sump pump is

manually turned on by opening HOV-11-246. This valve is manually operated to ensure that operations personnel inspect the cause and condition of any leakage before draining the sump and continuing operations. The level switch is operated off 24 vdc power. The sump pump operates in this manner for both local and remote HPW pump skid operation.

Local E-stop (XX-PMP-250, and -251)

The HPW pump skids have a local E-stop button conspicuously mounted to the front of the local control cabinet. Depressing this E-stop button de-energizes all electrically operated equipment on the skid. The E-stop operates in either local or remote operations.

SREE Cutting Jet Pump Subsystem

SREE Cutting Jet HPW Supply Pump (PMP-11-250 and -256)

The SREE cutting jet HPW pump is a 3-piston, positive displacement pump driven by a 75hp single speed, 480 vac, 3-phase drive. The pumps operate in a range of 0 gpm to 10 gpm as indicated by differential flow meters (FE PMP-11-250A&B and -256A&B) and 50 to 10,000 psig as indicated by discharge pressure transmitters (PT PMP-11-250 and -256). Locally the pump is controlled by a local control cabinet mounted "hand/off/auto" switch (HOA-PMP- 11-250 and -251) and a local control cabinet mounted 3-way pump/diverter valve control switch (HC PMP-11-250 and 256). Switching to the "hand" position enables the local pump controls and the 3-way switch starts the pump and directs the HPW to recycle or to the cutting jets. The pressure is locally controlled by adjusting the manual pressure control valve (HOV-11-230 and -244). The HPW supply pump is remotely controlled from the HMI features discussed in Section 1.0.

Pump Operation Interlocks:

- Low process water supply pressure >30 psi, signal from local hardware interlock switch (PSL PMP-11-250 and -256).
- Low pump crankcase lubricant level; signal from local hardware interlock switch (LSL PMP-11-250 and -256)
- High discharge pressure <10,000 psig; signal from slurry pressure transmitter (PT-PMP-11-250 and -256)
- Leak detected; signal from collection pan level switch (LSH SMP-11-250 and -256)
- RCS fault; signal from RCS
- Local E-stop; signal from local E-stop (XX-PMP-11-250 and -251)
- Soft S-stop; signal from the HMI
- Master On/Off; signal from the HMI

Supply/Recycle automatic diverter valves (AOV-11-230 and -242)

The supply/recycle diverter valve directs the HPW either to the cutting jets or to process water recycle. The valve is an air actuated automatic valve which is operated by a solenoid operated air valve. The solenoid valve is operated with 24 vdc digital signal. The solenoid valve signal is controlled locally by a local cabinet mounted hand switch (HC PMP-11-250 and 256). The valve is operated remotely from the HMI as discussed in Section 1.0.

Automatic pressure control valve (AOV-11-231 and –243)

The automatic pressure control valve is an air actuated valve operated by a closed loop controller (PY PMP-11-250 and -256) receiving an analog, 4-20 ma pressure feedback signal from the HPW pressure transmitter (PT PMP-11-250 and -256). The pressure input from the PLC and output signal to the PLC is 24 vdc, 4-20 ma signal. The control valve and transmitter operate in a range of 50 to 10,000 psig. The automatic pressure control valve can only be operated from commands from the HMI as discussed in Section 1.0. Local pressure control is performed through manual adjustment of manual pressure control valve (HOV-11-230 and -244) as described above.

Differential flow meters (FE PMP-11-250A&B and –256A&B)

The SREE cutting jet pump system has two flow meters, one on the pump process water inlet (FE PMP-11-250A and -256A) and one on the recycle line (FE PMP-11-250B and -256B) returning process water to the site process water system. The flow of HPW supplied to the cutting jets is calculated by the PLC as the difference between the two flow meters. Each meter is powered by 24 vdc power and has a 4-20 ma analog output signal. This signal is distributed to the central control PLC and HMI calculates the differential flow and totals the water usage and displays the values on the HMI screens as discussed in Section 1.0.

Discharge pressure transmitters (PT PMP-11-250 and -256) and discharge pressure controller (PY PMP-11-250 and -256)

The HPW discharge pressure transmitter operates off 24 vdc power and outputs a 4-20 ma analog signal. This signal is used to control the pump discharge pressure in a closed control loop with the pressure controller (PY PMP-11-250 and -256). The controller sends an output control air signal to the pressure control valve (AOV-11-231 and -243) which controls the pressure. The SREE cutting jet HPW supply pump is interlocked to shut down when the output signal reaches 10,000 psig or more. The controller and pressure transmitter send and receive signal to/from the central control PLC and the HMI. The remote pump pressure displays and operations are as discussed in Section 1.0.

Waste Removal Jet Pump HPW Supply Subsystem

Waste removal jet[pump HPW supply pump (PMP-11-251 and -257)

The jet pump HPW supply pump is a 3-piston, positive displacement pump driven by a 75hp single speed, 480 vac, 3-phase, drive. The pumps operate in a range of 0 gpm to 10 gpm as indicated by differential flow meters (FE PMP-11-251A&B and –257A&B) and 50 to 10,000 psig as indicated by discharge pressure transmitters (PT PMP-11-251 and -257). Locally the pump is controlled by a local control cabinet mounted "hand/off/auto" switch (HOA-PMP- 11-251 and -257) and a local control cabinet mounted 3-way pump/diverter valve control switch (HC PMP-11-251 and 257). Switching to the "hand" position enables the local pump controls and the 3-way switch starts the pump and directs the HPW to recycle or to the cutting jets. The pressure is locally controlled by adjusting the manual pressure control valve (HOV-11-237 and -251). The HPW supply pump is remotely controlled from the HMI features discussed in Section 1.0.

Pump Operation Interlocks:

- Low process water supply pressure >30 psi, signal from local hardware interlock switch (PSL PMP-11-251 and -257).
- Low pump crankcase lubricant level; signal from local hardware interlock switch (LSL PMP-11-251 and -257)
- High discharge pressure <10,000 psig; signal from pressure transmitter
  (PT-PMP-11-251 and -257)
- Leak detected; signal from collection pan level switch (LSH SMP-11-250 and -256)
- RCS fault; signal from RCS
- Local E-stop; signal from local E-stop (XX-PMP-11-250 and -251)
- Soft S-stop; signal from the HMI
- Master On/Off; signal for HMI

Supply/Recycle automatic diverter valves (AOV-11-233 and -244)

The supply/recycle diverter valve directs the HPW either to the jet pump or to process water recycle. The valve is an air actuated automatic valve, which is operated by a solenoid operated air valve. The solenoid valve is operated with 24 vdc digital signal. The solenoid valve signal is controlled locally by a local cabinet mounted hand switch (HC PMP-11-251 and 257). The valve is operated remotely from the HMI as discussed in Section 1.0.

Automatic pressure control valve (AOV-11-234 and -245)

The automatic pressure control valve is an air actuated valve operated by a closed loop controller (PY PMP-11-251 and –257) receiving an analog, 4-20 ma pressure feedback signal from the HPW pressure transmitter (PT PMP-11-251 and 257). The pressure input from the PLC and output

signal to the PLC is 24 vdc. The control valve and transmitter operate in a range of 50 to 10,000 psig. The automatic pressure control valve can only be operated from commands from the HMI as discussed in Section 1.0. Local pressure control is performed through manual adjustment of manual pressure control valve (HOV-11-237 and -251) as described above.

Differential flow meters (FE PMP-11-251A&B and -257A&B)

The jet pump HPW supply pump system has two flow meters, one on the pump process water inlet (FE PMP-11-251A and -257A) and one on the recycle line (FE PMP-11-251B and -257B) returning process water to the site process water system. The flow of HPW supplied to the jet pump is calculated by the PLC as the difference between the two flow meters. Each meter is powered by 24 vdc power and has a 4-20 ma analog output signal. This signal is distributed to the central control PLC and HMI calculates the differential flow and totals the water usage and displays the values on the screens as discussed in Section 1.0.

Discharge pressure transmitters (PT PMP-11-250 and -256)and discharge pressure controller (PY PMP-11-250 and -256)

The HPW discharge pressure transmitter operates off 24 vdc power and outputs a 4-20 ma analog signal. This signal is used to control the pump discharge pressure in a closed control loop with the pressure controller (PY PMP-11-250 and -256). The controller sends an output control air signal to the pressure control valve (AOV-11-231 and -243) which controls the pressure. The jet pump HPW supply pump is interlocked to shut down when the output signal reaches 10,000 psig or more. The controller and pressure transmitter send and receive signal to/from the central control PLC and the HMI. The remote pump pressure displays and operations are as discussed in Section 1.0.

3.6 Hydraulic Power Unit Skids

The Hydraulic Power Unit (HPU) supplies hydraulic fluid under pressure to the SREE cutting jets rotational motor. The HPU can adjust the hydraulic flow to the SREE to control the cutting jets rotational speed.

The HPU is hardwired to the slurry's ET200M data and control node. The number of signals required by the HPU. The control signals includes hydraulic motor start and stop, hydraulic fluid flow control, hydraulic fluid flow sensor signal, fluid discharge pressure signal, hydraulic oil temperature, reservoir low warning and reservoir low-low signal, hydraulic filter clogged, and general fault signal.

The HPU has the following operations that happen without PLC control. These operations include hydraulic oil recirc pump operation and hydraulic oil cooler operation.

INFORMATION ONLY

3157

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

PROCESS CONTROL PLAN (RADON CONTROL SYSTEM)

DOCUMENT NO. 624-P622-36A

FOR THE

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL (AWR) PROJECT

SUBMITTED TO:

FLUOR FERNALD, INC.

CONTRACT NO. FSC 624

000591

INFORMATION ONLY

SYSTEM 20 RCS LOGIC DESCRIPTION

PHASE 1 - Radon (reduction) Control in the Silo 1 and Silo 2 Headspaces

During Phase 1, Silo 1 and 2 will be connected to the ventilation system via flexible ducts to the rigid ducts located on the pipe rack, the ventilation air is withdrawn from the Silos 1 and 2 and transferred to the Radon Control System (there will be no Sluicer, Emma or Slurry modules connected to the silo). The treated ventilation air is returned to the silos for the sweep ventilation. The desired pressure conditions are maintained by using an automatically controlled fan and damper system to maintain a predetermined line supply pressure to the silos. The RCS will continue to operate in this scheme while radon concentration in the silo head spaces is reduced to a concentration that will allow safe access for work activities in the silo area. The following paragraphs provide the detail description of the control logic which will be used for programming of the RCS – PLC.

1. Exhaust/Recirculation Fans FAN-20-001A and FAN-20-001B

The air from the silos is pulled out by one of the exhaust/recirculation variable speed drive fans FAN-20-001A or FAN-20-001B.

The air from each silo passes through their respective louver, LVR-20-001 and LVR-20-004 that serves to help maintain a negative pressure (vacuum) in each silo. The air supply to each silo passes through their respective louver, LVR-20-002 and LVR-20-003.

HMI will have a soft two-position selector switch 'FAN-20-001A - FAN-20-001B'. Operator will select the fan manually. Selected fan discharge damper DMP-20-017 or DMP-20-021 will open and selected fan will run. The other fan will be in standby mode. If running fan fails or is placed in LOCAL at fan, the PLC will send alarm to HMI, standby damper will open and standby fan will start automatically. The operator must press soft RESET button in the HMI to clear the alarm.

The stand-by fan will stay in operation unless the operator re-selects the previous fans for operation.

Alternating fans may be done by selecting the alternate fan on HMI or selecting the AUTO-rotation of the fans. This will allow auto-rotation of fans on a timed bases. There will be a password required to invoke this selection.

Each fan is controlled by the local HAND-0FF- AUTO three position switch (HOA-FAN-20-001A or HOA-FAN-20-001B). Switch will send two digital input (2CI) to the PLC for each fan. Both fan local switch will be in AUTO position during normal operation.

Hand position - Fan will run, the interlocks are by-passed. Speed is controlled by pendant on VSD (VSD must be in local position).

Off position - Fan will stop.

Auto position- Fan will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Fan will start-stop based on the run-standby logic. Fan will shutdown on any of the following conditions.

1. Unrelieved high or low pressure in silos (PDIT-SILO-20-001 and PDIT-SILO-20-002).
2. Both desiccant dryer and chiller (DDS-20-001A or B and CHR-20-001A or B) shutdown. Bypass these signals during fan start-up.
3. Respective discharge damper is closed.

In normal operation both fan soft elector switch will be in AUTO position.

Variable Speed Drives for the fans are located on the second floor of the RCS building and will have 'Remote-Local' selection for the speed control, in remote mode it will receive the 4-20 m A signal (AO) from the PLC based on the supply pressure transmitter PDIT-FAN-20-001A/B and will require signal from TTA in subsequent phases PID control, in local mode speed will be controlled from local control pendant on the VSD.

Speed of the fan will be manually controlled on the HMI screen.

VSD will receive start-stop signal (CO) from PLC and it will send run signal (CI) and (AI) 0-10 volts to the PLC/HMI.

Air flow transmitter FIT-FAN-20-001A/B will monitor air flow discharge from fan FAN-20-001A or B though the louver LVR-20-016 to stack and it will send 4-20 mA signal to the PLC, flow rate will be displayed locally and at the HMI and PLC when LVR-20-0016 is being operated and will log the flow data at _____ seconds interval. Operator will set the pressure desired, controller will modulate the louver LVR-20-016 to discharge pressure to the stack or modulate the louver LVR-20-015 to increase the pressure to the desired set point and as other users are added to the system.

Air flow transmitter FIT-FAN-20-001R will monitor air flow discharge from fan FAN-20-001A/B to suction side (recirc) and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval. This reading will be used to adjust the VSD to the desired total flow rate when system is isolated in startup.

Damper DMP-20-017 is open-close dampers and will isolate exhaust/recirculation fan FAN-20-001A discharge. Damper is controlled from local H-O-A switch HOA-DMP-20-017. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed

Auto position- Damper will open and close from the PLC/HMI (CO).

HMI will have soft OPEN-CLOSE-AUTO switch.

Soft Auto position – Damper will close/open based on run/standby logic. Damper will close on following conditions.

1. Fan shutdown (signal to be bypassed during opening of the damper).

Dampers DMP-20-017 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-20-017A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the fan.

Damper DMP-20-021 is open-close dampers and will isolate exhaust/recirculation fan FAN-20-001B discharge. Damper is controlled from local H-O-A switch HOA-DMP-20-021. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft OPEN-CLOSE-AUTO switch.

Soft Auto position – Damper will close/open based on run/standby logic. Damper will close on following conditions.

1. Fan shutdown (signal to be bypassed during opening of the damper).

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Dampers DMP-20-021 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-20-021A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the fan.

Differential pressure transmitter PDIT-FAN-20-001A/B monitors FAN-20-001A/B discharge pressure and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval. It will control exhaust louver LVR-20-016 on high pressure, and intake louver LVR-20-015 on low pressure. The set-point will be operator adjustable in the HMI.

2. **PDIT-SILO-20-002 monitors and controls the pressure inside the silo 2.**

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the dampers LVR-20-001, LVR-20-002 and LVR-20-016.

The targeted range of the operation is from 0.0 to -1.0 inches water gauge. Acceptable ranges of operation are 0.5 to –2 inches water gauge.

PDIT-SILO-20-001 monitors and controls the pressure inside the silo 1.

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the dampers LVR-20-003, LVR-20-004 and LVR-20-016.

The targeted range of the operation is from 0.0 to -1.0 inches water gauge. Acceptable ranges of operation are 0.5 to –2 inches water gauge.

3. **Dampers LVR-20-001 , LVR-20-002 and LVR-20-016 for Silo 2**

PLC shall control the silo 2 pressure by modulating the discharge air control louver LVR-20-001 and re-circulating air supply louver LVR-20-002. These louvers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-001 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-002 shall modulate to close to maintain the pressure.

If LVR-20-002 closes 100% and differential pressure is still high then the supply will increase due to 500 scfm being diverted to silo 1. Louver LVR-20-016 will open to exhaust air to the stack STK-20-001 to reduce the differential pressure. The flow transmitter FIT-FAN-20-001A/B will then control LVR-20-016 to exhaust the same flow as FIT-SILO-20-002.

Louvers LVR-20-001, 002 and 016 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-001 shall modulate to close. If differential pressure increases discharge louver LVR-20-001 shall modulate to open.

Air flow transmitter FIT-SILO-20-002 monitor air flow though the damper LVR-20-001 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

Dampers LVR-20-004, LVR-20-003 and LVR-20-016 for Silo 1

PLC shall control the silo 1 pressure by modulating the discharge air control louver LVR-20-004 and re-circulating air supply damper LVR-20-003. These louvers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-004 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-003 shall modulate to close to maintain the pressure.

If LVR-20-003 closes 100% and differential pressure is still high then the supply will increase due to 500 scfm being diverted to silo 2. Louver LVR-20-016 will open to exhaust air to the stack STK-20-001 to reduce the differential pressure. The flow transmitter FIT-FAN-20-001A/B will then control LVR-20-016 to exhaust the sample flow as FIT-SILO-20-001. This set point is additive.

Louvers LVR-20-003, 004 and 016 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each louver will have a controller in the HMI from which operator will be able to control modulating of the damper manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-004 shall modulate to close. If differential pressure increases, discharge air louver LVR-20-003 shall modulate to open.

Air flow transmitter FIT-SILO-20-001 monitor air flow though the louver LVR-20-004 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

4. **Fan recirculation louver LVR-20-020**

Recirculation louver LVR-20-020 shall modulate to maintain flow set point and flow transmitter FIT-FAN-20-001R so that the exhaust fan FAN-20-001A or B speed does not need to change during changing flows in the system.

Louvers LVR-20-020 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

Louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

5. **Makeup air louver LVR-20-015 and makeup air filter FLT-20-004**

A tee in the flow path before the exhaust fans provides makeup air to the closed air system through louver LVR-20-015.

Louver LVR-20-015 is a modulating louver, it supplies make-up air to compensate for the air exhausting from the louver LVR-20-016 through stack. Louver will receive modulating signal from pressure transmitter controller PDIT-FAN-20-001A/B.

Louver LVR-20-015 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

Air flow transmitter FIT-FLT-20-004 will monitor air flow from makeup air filter FLT-20-004 though the damper LVR-20-015 and it will send 4-20 m A signal to the PLC, flow rate will be displayed locally and at the controller in the HMI and PLC will log the flow data at _____ seconds interval.

Differential pressure transmitter PDIT-FLT-20-004 monitors differential pressure across filter FLT-20-004 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval. It will initiate the alarm in the HMI if differential pressure will be above the set-point. The set-point will be operator adjustable in the HMI.

6. **Roughing filters FLT-20-001A and B, Desiccant drying system DDS-20-001A and B and Chiller units CHR-20-001A and B.**

The pulled out air from Silo 1 and 2 passes through one train of the redundant roughing filters and desiccant drying system/chiller (A train or B train).

Differential pressure transmitter PDIT-SILO-20-003 monitors total differential pressure in header from both Silo 1 & 2 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval.

Moisture transmitter MT-TOT-20-001 monitors total moisture going in to the Desiccant dryer/chiller and it will send 4-20 m A signal (AI) to the PLC, moisture content will be displayed in the HMI and PLC will log the moisture data at ____ seconds interval.

Temperature transmitter TT-TOT-20-001 monitors air temperature going in to the Desiccant dryer/chiller and it will send 4-20 m A signal (AI) to the PLC, temperature will be displayed in the HMI and PLC will log the temperature data at ____ seconds interval.

Differential pressure transmitter PDIT-FLT-20-001A monitors differential pressure across roughing filter FLT-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high-high set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-DDS-20-001A monitors differential pressure across desiccant dryer DDS-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high-high set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-FLT-20-001B monitors differential pressure across roughing filter FLT-20-001B and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high-high set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-DDS-20-001B monitors differential pressure across desiccant dryer DDS -20-001B and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high-high set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Dampers DMP-20-001 and DMP-20-002 are open-close dampers and will isolate train 'A' desiccant dryer/roughing filter. Dampers are controlled from local H-O-A switches HOA-DMP-20-001 and HOA-DMP-20-002. Each switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will close on following conditions.

1. High-High differential pressure across roughing filter (PDIT-FLT-20-001A).

2. General alarm from desiccant dryer (DDS -20-001A) and chiller (CHR-20-001A).

Dampers DMP-20-001 and DMP-20-002 control valves (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-001A/B and ZS-DMP-20-002A/B will send a two digital input signals (2CI for each switch)to the PLC/HMI. Limit switches input shall become permissive for the control of the Desiccant dryer and the Chiller units.

Dampers DMP-20-003 and DMP-20-004 are open-close dampers and will isolate train 'B' desiccant dryer/roughing filter. Dampers are controlled from local H-O-A switches HOA-DMP-20-003 and HOA-DMP-20-004. Each switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI. HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will close on following conditions.

1. High-High differential pressure across roughing filter (PDIT-FLT-20-001B).

2. General alarm from desiccant dryer (DDS-20-001B) and chiller (CHR-20-001B).

Dampers DMP-20-003 and DMP-20-004 control valves (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-003A/B and ZS-DMP-20-004A/B will send a two digital input signals (2CI for each switch)to the PLC/HMI. Limit switches input shall become permissive for the control of the Desiccant dryer and the Chiller units.

There will be a soft selector switch 'DDS-20-001A – DDS-20-001B' in HMI, operator will select which train will be in operation. The selected train Chiller, Desiccant dryer and Roughing filter will run, it will shutdown on any of the following conditions. On shutdown it will send an alarm to HMI and a stand-by train will start.

1. High-High differential pressure across desiccant dryer.

2. High-High differential pressure across roughing filter.

3. High moisture signal from MT-CBD-20-001.

4. Train shutdown (chiller and dryer) because of internal problems and High-High water in dryer.

5. Soft timer in HMI timed out. Timer will be operator adjustable, range ----- hours.

Stand-by train will stay in operation unless Operator re-selects the previous train for operation. Alternating chiller/dryer may be done by reselecting a chiller/dryer on HMI. The operator must press soft RESET button in the HMI to clear the alarm.

Note that the when switchover occurs the online train shall stay open until the switch over train is open, the isolating damper valves will then shutdown the unit.

Desiccant dryers and Chiller units both works together, chiller unit shall be started first, it will give permissive signal to the desiccant dryer to start via plant PLC. Also if Desiccant dryer shutdown associated chiller will shutdown.

Upon existing the roughing filter, the ventilation air enters desiccant drying system (DDS-20-001A 0r DDS-20-001B) at 90 degree F and 100% relative humidity where steam is cooled and dehumidified to 40 degree F and 15% relative humidity. This

conditioning of the ventilation air in the desiccant drying system is achieved by using a precooling coil, regenerative desiccant wheel, post-cooling coil, closed loop reactivation system, and a condensate collection and transfer system. The precooling coil cools and dehumidifies the ventilation air to a stream that is 55 degree F saturated air. From the precooling coil, the air flows through a desiccant impregnated wheel where the air is dehumidified. The temperature of the air exiting the wheel is 98 degree F with moisture content of 5 grains per pound (moisture content that corresponds to 15% relative humidity and 40 degree F). Ventilation air from the desiccant wheel flows through a post-cooling coil where the air is cooled to the target temperature of 40-degree F before existing the desiccant drying system. Chilled water streams for the cooling coils within the desiccant drying system are provided by the chiller (CHR-20-001A or CHR-20-001B) located outside the RCS building.

Each Desiccant dryer (DDS-20-001A and DDS-20-001B) has a local control panel; the local panel will perform all unit control functions. Following interface signals will be sent or received from the plant PLC.

1. Common trouble alarm (shut down alarm) to the plant PLC.

2. Dryer run signal to the plant PLC.

3. Remote start-stop signal (NC dry contact) from the plant PLC.

Plant PLC/HMI will display all above information (GA-DDS-20-001A and GA-DDS-20-001B), there will be a soft H-O-A switch in the HMI.

Soft Auto position – Dryer will start-stop based on the run-standby logic. Dryer will shutdown on any following conditions.

1. Unrelieved high pressure in silos (PDIT-SILO-20-001 or PDIT-SILO-20-002)

2. Both re-circulation fan (FAN-20-001A/B) shutdown.

3. Respective chiller shutdown.

In normal operation both dryer soft elector switch will be in AUTO position.

Each Chiller unit (CHR-20-001A and CHR-20-001B) has a local control panel; the local panel will perform all unit control functions. Following interface signals will be sent or received from the plant PLC.

1. Chiller run signal to the plant PLC.

2. Common trouble alarm to the plant PLC.

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3. Remote start-stop signal (NC dry contact) from the plant PLC

Plant PLC/HMI will display all above information (GA-CHR-20-001A and GA-CHR-20-001B), there will be a soft H-O-A switch in the HMI.

Soft Auto position – Chiller will start-stop based on the run-standby logic. Chiller will shutdown on any of the following conditions.

1. Both re-circulation fan (FAN-20-001A/B) shutdown.

2. Respective dryer shutdown.

In normal operation both Chiller soft elector switch will be in AUTO position.

7. Carbon Beds CBD-20-001A, CBD-20-001B and CBD-20-002A, CBD-20-002B

Within the desiccant drying system the air stream is conditioned to 40 degree F and approximately 15% relative humidity. The air then passes through the carbon beds, CBD-20-001A, CBD-20-001B, CBD-20-002A and CBD-20-002B. The all four beds are operated in parallel. Each bed is aligned with a dedicated inlet and outlet damper for flow control and isolation. Modulating dampers and flow elements provided on the inlet of each bed allow flow to each bed to be reduced or increased on the basis of operations. The design flow for the RCS system is 1000 cubic feet per minute. Ventilation rates and sources vary during different phases of the RCS operation.

The treated air stream through each carbon bed is monitored individually for radon. In the event that elevated levels of radon are detected downstream of a carbon bed, the air flow through the affected bed will be reduced by adjusting the automatic air damper on the inlet side of the carbon bed. If performance of the bed continue to degrade, the motor operated damper downstream of the affected bed will be closed automatically and the airflow will be redistributed through the other carbon beds.

Moisture transmitter MT-CBD-20-001 monitors air moisture prior to carbon bed from Desiccant dryer/chiller and it will send 4-20 m A signal (AI) to the PLC, moisture content will be displayed at the controller in the HMI and PLC will log the moisture data at ____ seconds interval when exceed high set point.

The operator will select moisture controller humidity set point, if humidity goes above set point alarm will be displayed, stand-by train will start and running desiccant dryer/chiller train will be stopped.

Temperature transmitter TT-CBD-20-001 monitors air temperature entering carbon bed from the Desiccant dryer/chiller and it will send 4-20 m A signal (AI) to the PLC, temperature will be displayed in the HMI and PLC will log the temperature data at ____ seconds interval.

000602

Radiation transmitter RQIT-TOT-20-001 (Government Furnished Equipment) monitors radiation of air from silos to the dryers and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operator adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20 – 900,000 ?

A Master Flow Controller in the HMI will control four slave controllers (FIT-CBD-20-001A, FIT-CBD-20-001B, FIT-CBD-20-002A and FIT-CBD-20-002B) which will modulate damper for the carbon bed to evenly distribute flow to all beds, which are in operation. Operator will select the total flow set –point (adjustable range ___) for the master controller.

Louver LVR-20-017 modulates flow through carbon bed CBD-20-001A based on the signal from the flow controller in the HMI.

Louver LVR-20-017 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

Air flow transmitter FIT-CBD-20-001A will control air flow though the louver LVR-20-017 and it will send 4-20 m A signal to the PLC, flow controller will be displayed in the HMI, controller will have MAN-AUTO mode in manual mode operator will select the flow rate desired, In auto mode PLC will automatic set the flow rate based on the signal from master controller in the HMI. PLC will send modulating signal to the louver LVR-20-017. PLC will log the flow data at _____ seconds interval. Damper DMP-20-006 is permissive open until High-High radiation is detected.

Differential pressure transmitter PDIT-CBD-20-001A monitors differential pressure across carbon bed CBD-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high set point; operator will reset the alarm from the HMI. The set points will be operator adjustable in the HMI. High-High differential pressure alarm will also close the damper DMP-20-006 and LVR-20-017.

Radiation transmitter RQIT-CBD-20-001A (Government Furnished Equipment) monitors radiation breakthrough of carbon bed CBD-20-001A and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator

will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operated adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20- 400,000 pCi/L (Pico-Curies per liter)

In the event that elevated level of radon is detected (High alarm) the radon controller will reduce the airflow through carbon bed CBD-20-001A by adjusting automatic inlet damper LVR-20-017. Radon controller will override the signal from the flow controller. Flow to other carbon beds will automatically adjust to balance remainder of flow.

If performance of the bed continue to degrade (High-High alarm), alarm will be displayed and downstream damper DMP-20-006 will close, isolating the carbon bed.

Damper DMP-20-006 is an open-close damper and will isolate carbon bed CBD-20-001A. Damper is controlled from local H-O-A switch HOA-DMP-20-006. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft auto position – Damper will close automatic on any of the following conditions.

1. High-High differential pressure across carbon bed CBD-20-001A (signal from PDIT-CBD-20-001A).

2. High-High radiation alarm from radiation monitor RQIT-CBD-20-001A.

Damper DMP-20-006 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-006A/B will send a two digital input signals (2CI) to the PLC/HMI.

Louver LVR-20-021 modulates flow through carbon bed CBD-20-001B based on the signal from the flow controller in the HMI.

Louver LVR-20-021 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

000604

Air flow transmitter FIT-CBD-20-001B will control air flow though the louver LVR-20-021 and it will send 4-20 m A signal to the PLC, flow controller will be displayed in the HMI, controller will have MAN-AUTO mode in manual mode operator will select the flow rate desired, In auto mode PLC will automatic set the flow rate based on the signal from master controller in the HMI. PLC will send modulating signal to the louver LVR-20-021. PLC will log the flow data at _____ seconds interval. Damper DMP-20-008 is permissive open until High-High radiation is detected.

Differential pressure transmitter PDIT-CBD-20-001B monitors differential pressure across carbon bed CBD-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed high set point. It will initiate the alarm in the HMI if differential pressure will be above the high set point; operator will reset the alarm from the HMI. The set points will be operator adjustable in the HMI. High-High differential pressure alarm will also close the damper DMP-20-008 and LVR-20-021.

Radiation transmitter RQIT-CBD-20-001B (Government Furnished Equipment) monitors radiation breakthrough of carbon bed CBD-20-001B and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operated adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20- 400,000 pCi/L (Pico-Curies per liter)

In the event that elevated level of radon (High alarm) is detected he radon controller will reduce the airflow through carbon bed CBD-20-001B by adjusting automatic inlet damper LVR-20-021. Radon controller will override the signal from the flow controller. Flow to other carbon beds will automatically adjust to balance remainder of flow.

If performance of the bed continue to degrade (High-High alarm), alarm will be displayed and downstream damper DMP-20-008 will close, isolating the carbon bed.

Damper DMP-20-008 is an open-close damper and will isolate carbon bed CBD-20-001A. Damper is controlled from local H-O-A switch HOA-DMP-20-008. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will close automatic on any of the following conditions.

1. High differential pressure across carbon bed CBD-20-001B (signal from PDIT-CBD-20-001A).

2. High-High radiation alarm from radiation monitor RQIT-CBD-20-001B.

Dampers DMP-20-008 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-008A/B will send a two digital input signals (2CI) to the PLC/HMI.

Louver LVR-20-006 modulates flow through carbon bed CBD-20-002A based on the signal from the flow controller in the HMI.

Louver LVR-20-006 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

Air flow transmitter FIT-CBD-20-002A will control air flow though the louver LVR-20-006 and it will send 4-20 m A signal to the PLC, flow controller will be displayed in the HMI, controller will have MAN-AUTO mode in manual mode operator will select the flow rate desired, In auto mode PLC will automatic set the flow rate based on the signal from master controller in the HMI. PLC will send modulating signal to the louver LVR-20-006. PLC will log the flow data at _____ seconds interval. Flow controller will also open damper DMP-20-010 when airflow is required.

Differential pressure transmitter PDIT-CBD-20-002A monitors differential pressure across carbon bed CBD-20-002A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed High set point. It will initiate the alarm in the HMI if differential pressure will be above the High set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI. High-High differential pressure alarm will also close the damper DMP-20-010 and LVR-20-006.

Radiation transmitter RQIT-CBD-20-002A (Government Furnished Equipment) monitors radiation breakthrough of carbon bed CBD-20-002A and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator

will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operated adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20- 400,000 pCi/L (Pico-Curies per liter)

In the event that elevated level of radon is detected (High alarm) the radon controller will reduce the airflow through carbon bed CBD-20-002A by adjusting automatic inlet damper LVR-20-006. Radon controller will override the signal from the flow controller. Flow to other carbon beds will automatically adjust to balance remainder of flow.

If performance of the bed continue to degrade (High-High alarm), alarm will be displayed and downstream damper DMP-20-010 will close, isolating the carbon bed.

Damper DMP-20-010 is an open-close damper and will isolate carbon bed CBD-20-002A. Damper is controlled from local H-O-A switch HOA-DMP-20-010. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will close automatic on any of the following conditions.

1. High differential pressure across carbon bed CBD-20-002A (signal from PDIT-CBD-20-002A).

2. High-High radiation alarm from radiation monitor RQIT-CBD-20-002A.

Dampers DMP-20-010 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-010A/B will send a two digital input signals (2CI) to the PLC/HMI.

Louver LVR-20-005 modulates flow through carbon bed CBD-20-002B based on the signal from the flow controller in the HMI.

Louver LVR-20-005 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for its position indication.

Air flow transmitter FIT-CBD-20-002B will control air flow though the louver LVR-20-005 and it will send 4-20 m A signal to the PLC, flow controller will be displayed in the HMI, controller will have MAN-AUTO mode in manual mode operator will select the flow rate desired, In auto mode PLC will automatic set the flow rate based on the signal from master controller in the HMI. PLC will send modulating signal to the louver LVR-20-005. PLC will log the flow data at _____ seconds interval. Damper DMP-20-012 is permissive open until High-High radiation is detected.

Differential pressure transmitter PDIT-CBD-20-002B monitors differential pressure across carbon bed CBD-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceeds High set point. It will initiate the alarm in the HMI if differential pressure will be above the High set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI. High-High differential pressure alarm will also close the damper DMP-20-012 and LVR-20-005.

Radiation transmitter RQIT-CBD-20-002B (Government Furnished Equipment) monitors radiation breakthrough of carbon bed CBD-20-002B and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operated adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20- 400,000 pCi/L (Pico-Curies per liter)

In the event that elevated level of radon (High alarm) is detected he radon controller will reduce the airflow through carbon bed CBD-20-002B by adjusting automatic inlet louver LVR-20-005. Radon controller will override the signal from the flow controller. Flow to other carbon beds will automatically adjust to balance remainder of flow.

If performance of the bed continue to degrade (High-High alarm), alarm will be displayed and downstream damper DMP-20-012 will close, isolating the carbon bed.

Damper DMP-20-012 is an open-close damper and will isolate carbon bed CBD-20-002B. Damper is controlled from local H-O-A switch HOA-DMP-20-012. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will close automatic on any of the following conditions.

1. High differential pressure across carbon bed CBD-20-002B (signal from PDIT-CBD-20-002B).

2. High-High radiation alarm from radiation monitor RQIT-CBD-20-002B.

Damper DMP-20-012 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-012A/B will send a two digital input signals (2CI) to the PLC/HMI.

8. **Condensate hold-up tanks TNK-20-002A and TNK-20-002B.**

Condensed liquids from the desiccant drying system are transferred to a 3000-gallon hold-up tanks TNK-20-002A and TNK-20-002B by a condensate pump located within each desiccant drying system. The liquid is held for as much as 40 days in the tanks to allow radon decay. Subsequently the liquid is dispositioned by an operator-initiated transfer by pumps (PMP-20-001A or PMP-20-001B or both) in one of two ways:

a. *Transfer to TTA distribution equipment enclosure for subsequent distribution to one of the four transfer storage tanks.*

b. *Transfer to the Advanced Wastewater Treatment (AWWT) plant after sampling, analysis and radiological survey indicates the condensate meets the waste acceptance criteria.*

Transfer to TTA will be the normal way of operation, manual ball valve to the AWWT will be normally closed and manual ball valve to TTA will be normally open.

Level indicator transmitter LIT-TNK-20-002A indicates and monitor the water level in hold-up tank TNK-20-002A and will send 4-20 m A signal (AI) to the PLC, level will be displayed at the HMI. Operator will select the high and low soft level switch set point. It will initiate tank switch over from TNK-20-002A to TNK-20-002B by closing MOV-20-003 and opening MOV-20-004.

Level switch LSHH-TNK-20-002A monitors High-High water level in hold-up tank TNK-20-002A and will send digital input (CI) to the PLC, alarm will be displayed in the HMI.

Level switch LSLL-TNK-20-002A monitors Low-Low water level in hold-up tank TNK-20-002A and will send digital input (CI) to the PLC, alarm will be displayed in the HMI, transfer pump PMP-20-001A or PMP-20-001B will stop and the associated valve MOV-20-001 or MOV-20-002will close.

Differential pressure transmitter PDIT-TNK-20-002A monitors pressure in the hold-up tank TNK-20-002A and it will send 4-20 m A signal (AI) to the PLC, pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if set points are exceeded. It will initiate the alarm in the HMI if pressure will be above the set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Automatic ball valve MOV-20-001 is open-close motor operated hold-up tank TNK-20-002A discharge valve. Valve is controlled from local H-O-A switch HOA-MOV-20-001. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Valve will open, the interlocks are by-passed.

Off (close) position – Valve will close, the interlocks are by-passed.

Auto position- Valve will open and close from the PLC/HMI.

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Valve will open based on selection to open from operator to transfer to TTA or AWWT and close based on the signal from the level transmitter LIT-TNK-20-002A. Level switch LSL from HMI will initiate closing valve MOV-20-001 and stopping pump PMP-20-001A. LSLL-20-002A will be a back-up close signal.

Ball valve motor (open/close) will receive control signal (CO) from the PLC. Valve limit switch (valve open or close indication) ZS-MOV-20-001A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to transfer pump PMP-20-001A.

Transfer pump PMP-20-001A transfer condensate from hold-up tank TNK-20-002A to AWWT or TTA. Pump is controlled by the local HAND-OFF-AUTO three-position switch (HOA-PMP-20-001A). Switch will send two digital input (2 CI) to the PLC.

Hand position - Pump will run, the interlocks are by-passed.

Off position - Pump will stop.

Auto position- Pump will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Pump will stop based on the signal from the level transmitter LIT-TNK-20-002A. Level switch LSLL-20-002A will be back-up stop signal. Starting of pump will be a manual start on HMI once sample has been cleared to transfer. Valve MOV-20-001 limit switch open will be a permissive to start pump. Selection to transfer will be determined by operator. Transfer to Transfer Tank Area will be done by selection of MOV-12-012. If transfer to AWWT, password will be required and flow rate input will determine which flow control valve will be used. If only PMP-20-001A is used FCV-AWT-20-001 will be used. If both pumps PMP-20-001A and PMP-20-001B are used FCV-AWT-20-002 will be used.

Automatic ball valve MOV-20-003 is open-close motor operated hold-up tank TNK-20-002A inlet valve. Valve is controlled from local H-O-A switch HOA-MOV-20-003. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Valve will open, the interlocks are by-passed.

Off (close) position – Valve will close, the interlocks are by-passed.

Auto position- Valve will open and close from the PLC/HMI.

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Valve will open based on tank selection of tank and close based on the signal from the level transmitter LIT-TNK-20-002A. Level switch LSH from HMI will initiate closing valve MOV-20-003 and opening valve MOV-20-004.

Ball valve motor (open/close) will receive control signal (CO) from the PLC. Valve limit switch (valve open or close indication) ZS-MOV-20-003A/B will send a two digital input signals (2CI) to the PLC/HMI.

Automatic ball valve MOV-12-012 is open-close motor operated valve located in Transfer tank system (**TTA**) to open for transfer of condensate to the TTA and provide permissive for transfer pumps PMP-20-001A and/or PMP-20-001B. Valve is controlled from local H-O-A switch HOA-MOV-12-012. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Valve will open, the interlocks are by-passed.

Off (close) position – Valve will close, the interlocks are by-passed.

Auto position- Valve will open and close from the PLC/HMI.

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Valve will open based on selection to transfer to TTA and close based on the signal from shutdown of both pumps PMP-20-001A and PMP-20-001B.

Ball valve motor (open/close) will receive control signal (CO) from the PLC. Valve limit switch (valve open or close indication) ZS-MOV-12-012A/B will send a two digital input signals (2CI) to the PLC/HMI. If MOV-12-012 is open, disable PID loops for both FCV-AWT-20-001 and FCV-AWT-20-002.

Indicating pressure transmitter PIT-PMP-20-001A monitors discharge pressure of transfer pump PMP-20-001A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds when PMP-20-001 is energized. It will initiate an alarm in the HMI if pressure exceeds set point. The set point will be operator adjustable in the HMI.

Level indicator transmitter LIT-TNK-20-002B indicates and monitors the water level in hold-up tank TNK-20-002B and will send 4-20 m A signal (AI) to the PLC, level will be displayed at the HMI. Operator will select the high and low soft level switch set point. It will initiate switch over from TNK-20-002B to TNK-20-002A by closing MOV-20-004 and opening MOV-20-003.

Level switch LSHH-TNK-20-002B monitors High-High water level in hold-up tank TNK-20-002B and will send digital input (CI) to the PLC, alarm will be displayed in the HMI.

Level switch LSLL-TNK-20-002B monitors Low-Low water level in hold-up tank TNK-20-002B and will send digital input (CI) to the PLC, alarm will be displayed in the HMI, transfer pump PMP-20-001A or PMP-20-001B will stop and the associated valve MOV-20-001 or MOV-20-002 will close.

Differential pressure transmitter PDIT-TNK-20-002B monitors pressure in the hold-up tank TNK-20-002B and it will send 4-20 m A signal (AI) to the PLC, pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if set points are exceeded. It will initiate the alarm in the HMI if pressure will be above the set point; operator will reset the alarm from the HMI. The set point will be operator adjustable in the HMI.

Automatic ball valve MOV-20-002 is open-close motor operated hold-up tank TNK-20-002B discharge valve. Valve is controlled from local H-O-A switch HOA-MOV-20-002. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Valve will open, the interlocks are by-passed.

Off (close) position – Valve will close, the interlocks are by-passed

Auto position- Valve will open and close from the PLC/HMI.

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Valve will open based on selection to open from operator to transfer to TTA or AWWT and close based on the signal from the level transmitter LIT-TNK-20-002B. Level switches LSL from HMI will initiate closing valve MOV-20-002. LSLL-20-002B will be a back-up close signal.

Ball valve motor (open/close) will receive control signal (CO) from the PLC. Valve limit switch (valve open or close indication) ZS-MOV-20-002A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to transfer pump PMP-20-001B.

Transfer pump PMP-20-001B transfer condensate from hold-up tank TNK-20-002B to AWWT or TTA. Pump is controlled by the local HAND-OFF-AUTO three-position switch (HOA-PMP-20-001B). Switch will send two digital input (2 CI) to the PLC.

Hand position - Pump will run, the interlocks are by-passed.

Off position - Pump will stop.

Auto position- Pump will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Pump will stop based on the signal from the level transmitter LIT-TNK-20-002B. Level switch LSLL-20-002B will be back-up stop signals and valve MOV-20-002 limit switch will be a permissive signal to start.

Transfer pump will send run signal to the automatic ball valve **MOV-12-012**, located in Transfer tank system (**TTA**) to open for transfer of condensate.

Automatic ball valve MOV-20-004 is open-close motor operated hold-up tank TNK-20-002B inlet valve. Valve is controlled from local H-O-A switch HOA-MOV-20-004. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Valve will open, the interlocks are by-passed.

Off (close) position – Valve will close, the interlocks are by-passed.

Auto position- Valve will open and close from the PLC/HMI.

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Valve will open based on tank selection of tank and close based on the signal from the level transmitter LIT-TNK-20-002B. Level switch LSH from HMI will initiate closing valve MOV-20-004 and opening valve MOV-20-003.

Ball valve motor (open/close) will receive control signal (CO) from the PLC. Valve limit switch (valve open or close indication) ZS-MOV-20-004A/B will send a two digital input signals (2CI) to the PLC/HMI.

Indicating pressure transmitter PIT-PMP-20-001B monitors discharge pressure from 0f transfer pump PMP-20-001B and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval when PMP-20-001B is energized. It will initiate an alarm in the HMI if pressure exceed set point. The set point will be operator adjustable in the HMI.

Flow transmitter FT-PMP-20-001 controls flow to **AWWT**, it will send 4-20 mA signal (AI) to the PLC, flow controller in the HMI will display the flow. Operator will select the flow rate desired, flow controller will send a signal (AO) to the modulating flow control valve FCV-AWT-20-001 to control the flow. Valve will send 4-20 m A feedback signal (AI) to the PLC for its position indication.

Flow transmitter FT-PMP-20-002 controls flow to **AWWT**, it will send 4-20 mA signal (AI) to the PLC, flow controller in the HMI will display the flow. Operator will select the flow rate desired, flow controller will send a signal (AO) to the modulating flow control valve FCV-AWT-20-002 to control the flow. Valve will send 4-20 m A feedback signal (AI) to the PLC for its position indication.

Damper DMP-20-032 is an open-close damper and will isolate tank TNK-20-002A. Damper is controlled from local H-O-A switch HOA-DMP-20-032. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will operate in automatic on any of the following conditions.

1. Open on high positive set point from PDIT-TNK-12-001A.

2. Close on low set point from PDIT-TNK-12-001A.

Damper DMP-20-032 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-032A/B will send a two digital input signals (2CI) to the PLC/HMI.

Damper DMP-20-033 is an open-close damper and will isolate tank TNK-20-002A. Damper is controlled from local H-O-A switch HOA-DMP-20-033. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will operate in automatic on any of the following conditions.

1. Open on high positive set point from PDIT-TNK-12-001B.

2. Close on low set point from PDIT-TNK-12-001B.

Damper DMP-20-033 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-033A/B will send a two digital input signals (2CI) to the PLC/HMI.

9. Drying of Carbon Bed.

In the event that a carbon bed needs to be dried, PLC will isolate the individual bed from the others. A take-off stream from the recirculation fans will be heated and passed through the affected carbon beds using induced draft fan (FAN-20-003). From this fan drying air stream will be sent to the running Desiccant dryer.

Following is the detail description of the logic for the drying of one carbon bed CBD-20-001; this will be typical for the other three-carbon beds.

Close normally open manual damper DMP-20-043, and place automatic damper DMP-20-006 in closed position using local H-O-A switch (alarm will be displayed in the HMI), this will isolate the carbon bed from desiccant dryer air stream.

Open normally closed manual dampers DMP-20-005, DMP-20-037,and DMP-20-073.

Carbon bed is now ready for the drying operation.

Damper LVR-20-019 modulates flow through carbon bed based on the signal from the flow controller (FIT-DHT-20-001) in the HMI. Operator will manually select the flow rate desired.

Damper LVR-20-019 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Air flow transmitter FIT-DHT-20-001 monitor air flow to duct heater DHT-20-001 through damper LVR-20-19 and it will send 4-20 m A signal to the PLC, flow rate will be displayed at the controller in the HMI and it will give start-stop signal to the duct heater controller IZ-DHT-20-001 and drying fan FAN-20-003. PLC will log the flow data at _____ seconds interval when in operation.

Temperature transmitter TT-DHT-20-001 monitors air temperature entering the drying carbon bed from the duct heater DHT-20-001 and it will send 4-20 m A signal (AI) to the PLC, temperature will be displayed at the controller in the HMI, operator will set the desired temperature set point and controller will send a feedback signal to the duct heater temperature controller IZ-DHT-20-001. The PLC will log the temperature data at ____ seconds interval when in operation.

Duct Heater DHT-20-001 heats a take-off air stream from the recirculation fan. It has a local control panel that performs all unit control functions (IZ-DHT-20-001). Heater will be turn on-off from the local panel, it will receive permissive signal (CO) from the plant PLC (FIT-DHT-20-001). Heater temperature will be controlled from the plant PLC (TT-DHT-001) 4-20 m A signal (AO).

Damper DMP-20-045 is open-close dampers and will isolate drying fan FAN-20-003. Damper is controlled from local H-O-A switch HOA-DMP-20-045. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft OPEN-CLOSE-AUTO switch.

Soft Auto position – Damper will close automatic on any of the following conditions.

1. Drying fan shutdown (signal to be bypassed during opening of the damper).

Damper DMP-20-045 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-20-045A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the drying fan.

Drying Fan FAN-20-003 provides pressure suction to carbon bed regeneration and it will transfer drying air stream to the Desiccant dryer. Fan is controlled by the local HAND-OFF-AUTO three-position switch (HOA-FAN-20-003). Switch will send two digital input (2 CI) to the PLC.

Hand position - Fan will run, the interlocks are by-passed.

Off position - Fan will stop.

Auto position- Fan will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Fan will start based on operator selection on HMI screen. The fan will stop based on the permissive signal from the damper DMP-20-045 limit switch and operator selection on HMI screen.

After carbon bed is dried, operator will manually stop FAN-20-003, louver LVR-20-019 will close and damper DMP-20-045 will close, this will shut off the duct heater IZ-DHT-20-001. Operator will manually close dampers DMP-20-037, DMP-20-043, DMP-20-073, and restored damper DMP-20-006 to its AUTO position.

10. HEPA Filter FLT-20-002A and FLT-20-002B.

The treated gas stream flows from the carbon adsorption units through a redundant high efficient HEPA filtration unit (only one unit will be on line FLT-20-002A or FLT-20-00B) before entering the recirculation fan (FAN-20-001A or FAN-20-001B), For redistribution to the silo or exhaust through the monitored stack STK-20-001.

Temperature transmitter TT-CBD-20-002 monitors air temperature exiting carbon bed and to the HEPA filter and it will send 4-20 m A signal (AI) to the PLC, temperature will be displayed in the HMI and PLC will log the temperature data at ____ seconds interval. It will initiate the alarm in the HMI if temperature exceeds set point. Operator will reset the alarm from the HMI. The high set point will be operator adjustable in the HMI.

Moisture transmitter MT-CBD-20-002 monitors air moisture after carbon bed and to the HEPA filter and it will send 4-20 m A signal (AI) to the PLC, moisture content will be displayed in the HMI and PLC will log the moisture data at ____ seconds interval. It will initiate the alarm in the HMI if moisture exceeds set point. Operator

will reset the alarm from the HMI. The high set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-FLT-20-002A monitors differential pressure across HEPA filter FLT-20-002A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed High set point. It will initiate the alarm in the HMI if differential pressure will be above the High set point; operator will reset the alarm from the HMI. The High set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-FLT-20-002B monitors differential pressure across HIPA filter FLT-20-002B and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed High set point. It will initiate the alarm in the HMI if differential pressure will be above the High set point; operator will reset the alarm from the HMI. The High set point will be operator adjustable in the HMI.

On high differential pressure alarm from the HEPA filter, operator will manually switch the airflow to the standby HEPA filtration unit and change the filter of the clogged filtration unit.

11. Exhaust Stack STK-20-001

During normal operation treated gas stream is exhausted to the atmosphere via monitored stack STK-20-001 based on control set point on pressure in the supply duct. In the event of out-of-parameter condition detected volume of treated gas stream exhausted to the atmosphere may be increased or decreased. The RCS building ventilation air (System 77) is continuously exhausted via stack.

Radiation transmitter RQIT-STK-20-001 (Government Furnished Equipment) monitors radiation level in the stack STK-20-001 and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact signal (programmable) to the PLC. Radiation data will be displayed at the controller in the HMI. Operator will set two set points (High and High-High) and when set points are reached, alarm will be displayed. Set points will be operated adjustable.

Model - Pylon 'CRM-1' continuous active radon monitor.

Range - 20- 200,000 pCi/L (Pico-Curies per liter)

During Silos headspace reduction (phase 1) High-High radon alarm will cause the entire system to shutdown.

During TTA ventilation (Phase 2A, 2B, 2C and 3) High-High radon alarm will cause the entire system to shutdown.

Level switch LSH-STK-20-001 monitors the stack sump water level, on high level, it will send a digital input signal (CI) to the PLC and displayed the alarm condition in HMI. Switch will have dead-bend for the pump start-stop signals.

12. RCS building sump SMP-20-001

Level switch LSH-SMP-20-001 monitors the building sump water level, on high level, it will send a digital input signal (CI) to the PLC and displayed the alarm condition in HMI. Switch will have dead-band for the pump start-stop signals.

Sump pumpPMP-20-003 transfer water from building sump to the hold-up tanks TNK-20-002A and TNK-20-002B. Pump is controlled by the local HAND-OFF-AUTO three-position switch (HOA-PMP-20-003). Switch will send two digital input (2 CI) to the PLC.

Hand position - Pump will run, the interlocks are by-passed.

Off position - Pump will stop.

Auto position- Pump will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Pump will start based on selection from HMI and stop based on the signal from the level switch LSH-SMP-20-001 (switch has a dead-band for start-stop).

13. System Shutdown.

Following conditions will cause system shutdown.

a. Unrelieved high/low-pressure in Silos.

b. Both recirculation fan (FAN-20-001A/B) shutdown.

c. Both desiccant/chiller (DDS-20-001A/CHR-20-001A and DDS-20-001B/CHR-20-001B) train shutdown.

d. High-High stack radon levels.

System shutdown signal will cause following shutdown of the equipment and open/close of the Dampers.

a. Recirculation fans FAN-20-001A and B.

000019

b. Desiccant dryers DDS-20-001A and B

c. Chillers CHR-20-001A and B

d. Close stack exhaust louver LVR-20-016

e. Close make-up louver LVR-20-015

f. Close Silo supply louvers LVR-SILO-20-002 and LVR-SILO-20-003

14. Telemetry

Following out of parameter conditions will dial out and/or page a designated number to alert the on-call responsible person. PLC will send a contact input to the Auto Dialer (8 channel) for each condition.

a. Unrelieved high/low-pressure in Silos.

b. Both recirculation fan (FAN-20-001A/B) shutdown.

c. Both desiccant/chiller (DDS-20-001A/CHR-20-001A and DDS-20-001B/CHR-20-001B)

d. High radon alarm at stack STK-20-001 (RQIT-STK-20-001).

e. High-High radon alarm in any of the carbon beds.

f. High differential pressure in either of the filter trains FLT-20-002A or FLT-20-002B.

15. Evacuation Alarms

Following alarms will be sent to the Vitrification Pilot Plan (VitPP) control room evacuation system, for local evacuation alarms activation.

a. High-High radiation alarm from stack radiation monitor RQIT-STK-20-001 ?

16. Condensate Traps

Flexible air duct from Silo 1 and Silo 2 will have condensate trap, each trap will be monitored by level switch. Level switch LS-SILO-20-001 and LS-SILO-20-002 will send an alarm signal (CI) to the PLC. Operator action will be taken to remove water from traps.

A condensate trap within the RCS building will be monitored by level switches. Level switches LSH-CND-20-002 and LSHH-CND-20-001 will send alarm signals (CI) to PLC. Operator will open valve SOV-20-001 to allow condensate to gravity drain to hold up tank. Afterwards operator will close valve SOV-20-001.

17. Loss of normal Electrical Power

A standby Diesel Generator (800 KW) is provided for the back-up power for the RCS building equipment. In case of normal power failure a monitoring relay will initiate a signal to the diesel generator to start. When the generator reaches at its rated voltage the transfer-switch will transfer all electrical loads (MCC-3) to the generator.

Generator will send run signal to the PLC.

Transfer to the generator power will take about ------ seconds, during this time following events will take place.

1. All running motors (fan and pumps) will start to slow down or stop.
2. All motor run signals to the PLC will be lost. PLC will over-ride these signals during power transfer.
3. All motor operated dampers (open/close) will stay in same position (UPS power).
4. All modulating dampers will stay in same position (UPS power).
5. PLC inputs/outputs will not be affected because of UPS power.

Packaged Equipment – When equipment controls are in automatic mode, on loss of normal 480 Volt electrical power supply, equipment shall automatically start again when 480 Volt power supply returns (Standby Diesel Generator). If required equipment control power shall be supplied from Un-interuptable Power Supply (UPS).

<u>Phase 2A - Silo 1 Retrieval, Silo 2 Headspace Reduction and TTA ventilation</u>

When mining activities begin in Silo 1, the RCS moves from Phase 1 to Phase 2A. During this phase, recirculation air to Silo1 will be discontinued or reduced and the ventilation air is pulled through the three enclosures (Sluicer, EMMA and Slurry modules) on the pivoting bridge that are used for waste retrieval from Silo 1. Silo 2 continues to operate as before in Phase 1.

At the start of Phase 2A, the damper in the supply (recirculation) air duct to Silo 1 (The first silo to be emptied), LVR-20-003 closes automatically upon opening of the

INFORMATION ONLY
3157

any one of the dampers DMP-11-002, DMP-14-002 or DMP-11-005 due to the increase in flow to the other silo.

1. **Slurry, EMMA and Sluicer Modules**

Differential pressure transmitter PDIT-FLT-11-001 monitor differential pressure across **Slurry air filter FLT-11-001** and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval when damper DMP-11-002 is opened.

Damper DMP-11-002 is open-close damper and will isolate slurry module SLR-11-201 from slurry air filter FLT-11-001. Damper is controlled from local H-O-A switch HOA-DMP-11-002. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

Dampers DMP-11-002 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-11-002A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will send signal to recirculation damper LVR-20-003 to close.

Differential pressure transmitter PDIT-FLT-14-001 monitor differential pressure across **EMMA air filter FLT-14-001** and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval when DMP-14-002 is opened.

Damper DMP-14-002 is open-close damper and will isolate EMMA module EMA-14-401 from EMMA air filter FLT-14-001. Damper is controlled from local H-O-A switch HOA-DMP-14-002. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

Dampers DMP-14-002 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-14-002A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will send signal to recirculation damper LVR-20-003 to close.

000322

Differential pressure transmitter PDIT-FLT-11-003 monitor differential pressure across **Sluicer air filter FLT-11-003** and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval when DMP-11-005 is opened.

Damper DMP-11-005 is open-close damper and will isolate sluicer module SLC-11-204 from sluicer air filter FLT-11-003. Damper is controlled from local H-O-A switch HOA-DMP-11-002. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

Dampers DMP-11-005 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-11-005A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will send signal to recirculation damper LVR-20-003 to close.

2. **Transfer Tank Area (TTA)**

At the inception of Phase 2A, the TTA is tied into the RCS. The flow to the various major TTA components is controlled individually at each component. Air is drawn into the TTA through single manifold and distributed to the waste transfer tanks by modulating dampers. The filtrate storage tanks are vented to the RCS system.

During Phase 2A only two of the four-transfer storage tanks are in service (TNK-12-001A and TNK-12-001B).

Damper DMP-20-074 is an open-close damper and will isolate TTA area from exhaust/recirculation fan FAN-20-001A and FAN-20-001B. Damper is controlled from local H-O-A switch HOA-DMP-20-074. Switch will send two digital input (2CI) to the PLC. Damper will be normally closed during Phase 1.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will be normally open when TTA building is brought on line.

000023

Dampers DMP-20-074 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-0074A/B will send a two digital input signals (2CI) to the PLC/HMI. Damper will be slaved to the TTA fresh air intake damper DMP-20-070. Close when DMP-20-070 is open and open when DMP-20-070 is closed.

Transfer storage tanks TNK-12-001A and TNK-12-001B

Storage tanks TNK-12-001A and TNK-12-001B will be placed in the service and storage tanks TNK-12-002A and TNK-12-002B will be isolated by closing their respective dampers in manual mode during Phase 2A.

Air flow transmitter FIT-TNK-12-001A will monitor air flow discharge from transfer storage tank TNK-12-001A through damper LVR-20-008 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

Differential pressure transmitter PDIT-TNK-12-001A Monitors and controls the pressure inside the Transfer tank TNK-12-001A

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the louvers LVR-20-007 and LVR-20-008.

The operating target pressure range is between 0 and -1 inch water gauge. The acceptable range of the operation is from 0.0 to -1.0 inch water gauge.

Louvers LVR-20-007 and LVR-20-008 for Transfer storage tank TNK-12-001A

PLC shall control the transfer storage tank pressure by modulating the discharge air control louver LVR-20-008 and re-circulating air supply louver LVR-20-007. These dampers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-008 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-007 shall modulate to close to maintain the pressure.

Louvers LVR-20-007 and 008 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each Louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-008 shall modulate to open.

If louver LVR-20-007 is closed and LVR-20-008 is open, return flow will be set point for control of LVR-20-016. This set point is additive.

Air flow transmitter FIT-TNK-12-001B will monitor air flow discharge from transfer storage tank TNK-12-001B through louver LVR-20-010 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

Differential pressure transmitter PDIT-TNK-12-001B Monitors and controls the pressure inside the Transfer tank TNK-12-001B.

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the louvers LVR-20-009 and LVR-20-010.

The operating target pressure range is between 0 and -1 inches water gauge. The acceptable range of the operation is from 0.5 to -2.0 inches water gauge.

Louvers LVR-20-009 and LVR-20-010 for Transfer storage tank TNK-12-001B

PLC shall control the transfer storage tank pressure by modulating the discharge air control louver LVR-20-010 and re-circulating air supply louver LVR-20-009. These dampers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-010 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-009 shall modulate to close to maintain the pressure.

Louvers LVR-20-009 and 010 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-010 shall modulate to open.

If louver LVR-20-009 is closed and LVR-20-010 is open, return flow will be set point for control of LVR-20-016. This set point is additive.

Makeup air damper DMP-20-070 and TTA makeup air filter FLT-20-005

A tee in the flow path before the first tee to the transfer storage tanks provides a fresh makeup air to the TTA system through damper LVR-20-070. Damper may be opened during Phase 2A.

Damper DMP-20-070 is an open-close damper and will isolate makeup (fresh) air to the TTA. Damper is controlled from local H-O-A switch HOA-DMP-20-070. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open-Close switch.

Soft Auto position – Damper will be normally open, it will close automatically when stack radon monitor RQIT-STK-20-001 detects a high radon concentration.

Dampers DMP-20-070 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-070A/B will send a two digital input signals (2CI) to the PLC/HMI. Damper is slaved to DMP-20-074.

Differential pressure transmitter PDIT-FLT-20-005 monitors differential pressure across filter FLT-20-005 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval if exceed High set point. It will initiate the alarm in the HMI if differential pressure will be above the High set point. The set point will be operator adjustable in the HMI.

3. **Filtrate Storage Tanks TNK-12-003 and TNK-12-004**

RCS return from TTA tanks passes to the filtrate storage tanks, and then to desiccant drying system for recirculation.

Damper DMP-20-029 is an open-close damper and will isolate filtrate storage tank **TNK-12-003**. Damper is controlled from local H-O-A switch HOA-DMP-20-029. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have Soft Auto-Open-Close switch. Soft auto position-damper will operate in automatic on any of the following conditions.

1. Open on high positive set point from PDIT-TNK-12-003.

2. Close on low set point from PDIT-TNK-12-003.

Dampers DMP-20-029 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-029A/B will send a two digital input signals (2CI) to the PLC/HMI.

Differential pressure transmitter PDIT-TNK-12-003 monitors pressure of filtrate tank TNK-12-003 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval. It will initiate the alarm in the HMI if differential pressure will be above the set point. The set point will be operator adjustable in the HMI.

Damper DMP-20-030 is an open-close damper and will isolate filtrate storage tank **TNK-12-004**. Damper is controlled from local H-O-A switch HOA-DMP-20-029. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

HMI will have Soft Auto-Open-Close switch. Soft Auto position-Damper will operate on automatic on any of the following conditions:

1. Open on high positive set point from PDIT-TNK-12-004.

2. Close on low set point from PDIT-TNK-12-004.

Dampers DMP-20-030 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-20-030A/B will send a two digital input signals (2CI) to the PLC/HMI.

Differential pressure transmitter PDIT-TNK-12-004 monitors pressure of filtrate tank TNK-12-004 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data at ____ seconds interval. It will initiate the alarm in the HMI if differential pressure will be above the set point. The set point will be operator adjustable in the HMI.

PHASE 2B - Silo 2 Retrieval and TTA Ventilation

At the beginning of Phase B the material retrieval activities shift to Silo 2, Silo 1 activities having been completed and ventilation of Silo 1 is stopped. The bridge is positioned over Silo 2. New position of the bridge will prevent re-connection of s Silo 2 flexible ventilation ducts to the dampers LVR-20-001 and LVR-20-002, because of this ventilation ducts will be connected to the Silo 1 dampers LVR-20-003 and LVR-20-004 to control pressure within Silo 2 during Phase 2. Dampers LVR-20-001 and LVR-20-004 are disconnected and closed during Phase 2 operation.

The ventilation strategy of Silo 2 during retrieval activities is identical to that of Silo 1.

At the start of Phase 2, the damper in the supply (recirculation) air duct to Silo 2, LVR-20-003 closes automatically upon opening of the any one of the dampers DMP-11-002, DMP-14-002 or DMP-11-005.

1. **Slurry, EMMA and Sluicer Modules**

Logic same as Phase 2A.

2. **Transfer Tank Area (TTA)**

At the conclusion of Phase 2A, flow to transfer storage tanks TNK-12-001A and TNK-12-001B will be reduced by closing their respective dampers in manual mode.

Transfer storage tanks TNK-12-002A and TNK-12-002B

Storage tanks TNK-12-002A and TNK-12-002B will be placed in service during Phase 2B.

Air flow transmitter FIT-TNK-12-002A will monitor air flow discharge from transfer storage tank TNK-12-002A through louver LVR-20-012 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

Differential pressure transmitter PDIT-TNK-12-002A Monitors and controls the pressure inside the Transfer tank TNK-12-002A.

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the louvers LVR-20-011 and LVR-20-012.

The operating target pressure range is between 0 and –1 inches water gauge. The acceptable range of the operation is from 0.5 to -2.0 inches water gauge.

Louvers LVR-20-011 and LVR-20-012 for Transfer storage tank TNK-12-002A

PLC shall control the transfer storage tank pressure by modulating the discharge air control louver LVR-20-012 and re-circulating air supply louver LVR-20-011. These dampers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-012 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-011 shall modulate to close to maintain the pressure.

Louvers LVR-20-011 and 012 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-012 shall modulate to open.

If louver LVR-20-011 is closed and LVR-20-012 is open, return flow will be set point for control of LVR-20-016. This set point is additive.

Air flow transmitter FIT-TNK-12-001B will monitor air flow discharge from transfer storage tank TNK-12-001B through louver LVR-20-010 and it will send 4-20 m A signal to the PLC, flow rate will be displayed in the HMI and PLC will log the flow data at _____ seconds interval.

Pressure differential transmitter PDIT-TNK-12-002B Monitors and controls the pressure inside the Transfer tank TNK-12-002B.

Range: -5" – 5" H2O

Pressure transmitter will send a 4-20 m A (AI) signal to the PLC and a PID control will maintain the pressure set point entered by the operator from HMI, by modulating the louvers LVR-20-013 and LVR-20-014.

The targeted operating pressure range is between 0 and -1 inches water gauge. The acceptable range of the operation is from 0.5 to -2.0 inches water gauge.

Louvers LVR-20-013 and LVR-20-014 for Transfer storage tank TNK-12-002B

PLC shall control the transfer storage tank pressure by modulating the discharge air control louver LVR-20-014 and re-circulating air supply damper LVR-20-013. These louvers will operate in a slave and master arrangement.

If differential pressure increases (decrease in vacuum) discharge air louver LVR-20-014 shall modulate to open, when it reaches 100% and if pressure is still high then re-circulating louver LVR-20-013 shall modulate to close to maintain the pressure.

Louvers LVR-20-013 and 014 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

Each louver will have a controller in the HMI from which operator will be able to control modulating of the louver manually or automatic based on the PLC logic.

If differential pressure decreases (increase in vacuum) discharge air louver LVR-20-014 shall modulate to open.

If louver LVR-20-013 is closed and LVR-20-014 is open, return flow will be set point for control of LVR-20-016. This set point is additive.

Makeup air damper DMP-20-070 and TTA makeup air filter FLT-20-005

Logic same as Phase 2A.

3. **Filtrate Storage Tanks TNK-12-003 and TNK-12-004**

Logic same as Phase 2A.

Conclusion of Phase 2B

At the conclusion of phase 2B, ventilation of Silo 2 is discontinued and the decant sump waste retrieval begins. During this activity (approximately one week duration) the modified sluicer module will be used to retrieve solid and liquid wastes from the decant sump. As in Phase 2A and Phase 2B operations, the modules enclosure provides the ventilation air for the decant sump. A temporary holdup tank used to receive decant sump waste will be vented to the RCS system. Because of the transient nature of this operation, steady state material balances are not required but RCS system ventilation will be balanced accordingly.

Differential pressure transmitter PDIT-FLT-11-005 monitors pressure across sluicer air filter FLT-11-005 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data

at ____ seconds interval. It will initiate the alarm in the HMI if differential pressure will be above the set-point. The set point will be operator adjustable in the HMI.

Damper DMP-11-004 is an open-close damper and will isolate sluicer module SLC-11-203. Damper is controlled from local H-O-A switch HOA-DMP-11-004. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI.

Dampers DMP-11-004 control motor (open/close) will receive control signal (CO) from the PLC. Damper limit switches (damper open or close indication) ZS-DMP-11-004A/B will send a two digital input signals (2CI) to the PLC/HMI.

Damper LVR-20-018 controls the pressure of the decant sump by modulating flow through sump based on the signal from controller in the HMI. Operator will manually select the flow rate desired.

Damper LVR-20-018 receives 4-20 m A signal (AO) from the PLC for control and sends 4-20 m A feedback signal (AI) to the PLC for it's position indication.

PHASE 2C – TTA Ventilation (Radon Control During Interim Storage)

At the conclusion of the material retrieval campaigns the Radon Control System ventilates various TTA components as required. Limited air flow can be maintained through TTA components during this phase.

The system will have flexibility to recycle treated air back through the TTA manifold or exhaust it through the stack

Close manual dampers DMP-20-059, DMP-20-060, and DMP-20-024, this will isolate silos from desiccant dryer.

Close manual dampers DMP-20-038 and DMP-20-039, this will isolate silos from circulating fans.

Increase airflow (500 CFM) in re-circulation loop to balance system for the reduced air users.

PHASE 3 – TTA Ventilation and Radon Control During Future Material Treatment

During Phase 3, the RCS will accommodate airflow of 500 cubic feet per minute from the future treatment system in addition to the 500 cubic feet per minute from the TTA. Dampers will control the balance between the two inputs.

If desired, the system can be operated in recycle mode so that air from the TTA would pass through the carbon beds and return to the TTA, in much same way the air is to be recycled through the silos during Phase 1. Input from the waste treatment should not be accepted during period of recycle.

Airflow through a TTA waste storage tank could be discontinued after transfer from that tank to the Future Waste Treatment Facility is complete.

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GENERAL CONTROL PHILOSOPHY

1. Radon Control will be a 24-hour continuos automatic operation. Operator will be in control room during 8-hour day shift. During off-shift hour Operator will be notified of out of parameter conditions via Auto Dialer

2. HMI graphic will have following Phase selector soft push buttons.

   PHASE 1
   Radon (reduction) Control in the Silo 1 and Silo 2 Headspaces

   PHASE 2A
   Silo 1 Retrieval, Silo 2 Headspace Reduction and TTA Ventilation

   PHASE 2B
   Silo 2 Retrieval and TTA Ventilation

   PHASE 2C
   TTA Ventilation (Radon Control During Interim Storage)

   PHASE 3
   TTA Ventilation and Radon Control During Future Material Treatment

   Selection of the Phase push button will be password protected.

3. PHASE 1 – Following conditions shall be implemented for operation.

   a. Block signals from Slurry, EMMA, and Sluicer modules damper limit switches (ZS-DMP-11-002A/B, ZS-DMP-14-002A/B and ZS-11-005A/B) from closing the recirculation damper LVR-20-003.

   b. Block venting of TTA storage tanks (TNK-12-001A, TNK-12-001B, TNK-12-002A and TNK-12-002B) by closing the respective supply and discharge dampers (LVR-20-007, LVR-20-008, LVR-20-009, LVR-20-010, LVR-20-011, LVR-20-012, LVR-20-013 and LVR-20-014). Close fresh makeup air supply damper DMP-20-070.

   c. Keep recirculation air (to TTA) damper DMP-20-074 closed.

   d. Block venting of filtrate storage tanks (TNK-12-003 and TNK-12-004) by closing the respective dampers (DMP-20-029 and DMP-20-030).

   e. Block venting of Decant sump by closing the damper LVR-20-018.

4. PHASE 2A - Following conditions shall be implemented for operation

   a. Block venting of transfer storage tanks TNK-12-002A and TNK-12-002B by closing the respective dampers (LVR-20-011, LVR-20-012, LVR-20-013 and LVR-20-014.

   b. Block signals from pressure transmitters PDIT-TNK-12-002A and PDIT-TNK-002B.

   c. Block signal from Silo 1 pressure transmitter PDIT-SILO-20-001.

4. PHASE 2B - Following conditions shall be implemented for operation.

   a. Block signals from and to the exhaust damper LVR-20-001 and recirculation damper LVR-20-002, these dampers will be disconnected and closed during phase 2B.

   b. Block signal from Silo 1 pressure transmitter PDIT-SILO-20-001.

   c. Block signal from Silo 2 pressure transmitter PDIT-SILO-20-002.

   d. Change graphic to show Silo 2 connection to dampers LVR-20-003 and LVR-20-004.

   e. Reduce venting of transfer storage tanks TNK-12-001A and TNK-12-001B by closing the respective dampers (LVR-20-07, LVR-20-008, LVR-20-009 and LVR-20-010).

   f. Block signals from pressure transmitters PDIT-TNK-12-001A and PDIT-TNK-12-001B.

5. PHASE 2C - Following conditions shall be implemented for operation

   a. Block signals from Silo 1 and 2 pressure transmitters PDIT-SILO-20-001 and PDIT-SILO-20-002.

   b. Block all signals to and from Slurry, EMMA, and Sluicer modules air filters and dampers (PDIT-FLT-011-001, DMP-11-002, PDIT-FLT-14-001, DMP-14-002, DMP-11-005 and PDIT-FLT-11-003).

   c. Increase air flow (------ CFM) through exhaust damper (LVR-20-016) to the stack STK-20-001. Operator will set the flow rate from controller FIT-FAN-20-001A/B.

6. PHASE 3 - Following conditions shall be implemented for operation

   a. Remove silos 1 and 2 from graphic.

   b. Increase air flow (------ CFM) through exhaust damper (LVR-20-016) to the stack STK-20-001. Operator will set the flow rate from controller FIT-FAN-20-001A/B.

7. Radiation monitors alarms settings (preliminary) for radiation monitors after carbon beds.

PHASE	HIGH AL pCi/L	HIGH-HIGH AL pCi/L
1		
2A		
2B		
2C		
3		

Note – Radiation monitor range (20-200,000) have to be changed if above set points are required.

8. Radiation monitor alarms settings (preliminary) for radiation monitors before carbon beds.

PHASE	HIGH AL pCi/L	HIGH-HIGH AL pCi/L
1		
2A		
2B		
2C		
3		

Note – Radiation monitor range (20-200,000) have to be changed if above set points are required.

9. Radiation monitor alarms settings (preliminary) for radiation monitor at stack.

PHASE	HIGH AL pCi/L	HIGH-HIGH AL pCi/L
1		
2A		
2B		
2C		
3		

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10. Radiation monitors alarms settings (preliminary) for radiation monitors inside the RCS building.

PHASE	HIGH AL pCi/L	HIGH-HIGH AL pCi/L
1		
2A		
2B		
2C		
3		

INFORMATION ONLY

Date 2- 22 –00

SYSTEM 77 RCS BLDG HVAC LOGIC DESCRIPTION

The building Heating and Ventilation System for the interior spaces of the RCS building is a once through system. The H & V system is comprised of a separate supply and a redundant exhaust system. The ducted supply system draws outside air into the building by the RCS building supply fan (FAN-77-003). The outside air enters through a filter (FLT-77-001) that reduces the amount of particulate loading in the intake system. Electric duct heaters (HTR-77-012A and B) will heat the supply air when outside temperature falls below design conditions.

Differential pressure in the 1st floor pump building, 4 carbon beds, and 2nd floor filter/fan building are monitored and alarmed if exceeds set point. Upset in each carbon bed area will be handled manually.

Redundant centrifugal Building Ventilation Exhaust Fan (FAN-77-001A or FAN-77-001B) ventilates the interior spaces of the RCS building. The fans and ducting system maintain the RCS building at a negative pressure. The RCS building ducting is manually balanced.

There are no interlocks between RCS building HV system and RCS system.

Differential pressure transmitter PDIT-FLT-77-001 monitors differential pressure across outside air supply filter FLT-77-001 and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed on the HMI and PLC will log the pressure data if it exceeds the high and high-high set point. It will initiate the alarm on the HMI if differential pressure exceeds the high or high-high set point. The set points will be operator adjustable on the HMI and will be password authorization.

Damper DMP-77-002 is open-close damper and will isolate supply air fan FAN-77-003. Damper is controlled from local H-O-A switch HOA-DMP-77-002. Switch will send two digital input (2CI) to the PLC.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed

Auto position- Damper will open and close from the PLC/HMI.

HMI will have soft Auto- Open- Close switch.

000037

Soft Auto position – Damper will close automatic when fan FAN-77-003 is de-energized. Damper will open when command start is initiated from HMI for start of FAN-77-003.

Damper DMP-77-002 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-77-002A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the supply fan.

Supply air Fan FAN-77-003 supplies outside air to the RCS building. Fan is controlled by the local HAND-OFF-AUTO three-position switch (HOA-FAN-77-003). Switch will send two digital input (2 CI) to the PLC.

Hand position - Fan will run, the interlocks are by-passed.

Off position - Fan will stop.

Auto position- Fan will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position - Fan will shutdown automatically on any of the following conditions.

1. High-High radiation alarm from radiation monitor RQIT-RCS-77-001.
2. Both vent fan FAN-77-001A and FAN-77-001B shutdown.
3. Damper DMP-77-002 is NOT open.

Differential pressure transmitter PDIT-RCS-77-001 monitors differential pressure of holdup tank TNK-20-001A area and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm on the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-RCS-77-002 monitors differential pressure of the second floor filter/fan area and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-RCS-77-003 monitors differential pressure of carbon bed CBD-20-001A area and it will send 4-20 m A signal (AI) to the PLC,

differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-RCS-77-004 monitors differential pressure of carbon bed CBD-20-001B area and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-RCS-77-005 monitors differential pressure of carbon bed CBD-20-002A area and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-RCS-77-006 monitors differential pressure of carbon bed CBD-20-002B area and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Duct Heaters HTR-77-012A and HTR-77-012B heats the supply air when outside air temperature falls below operator set point. Heater control is independent of the PLC and provides heat on demand and interlocks with air flow. Duct heater HTR-77-012A will heat the first floor air and heater HTR-77-012B will heat the second floor air. Signal of operation to PLC or temp in building or duct air temp behind heater is needed to verify operation of heaters.

Radiation transmitter RQIT-RCS-77-001 (Government Furnished Equipment) monitors radiation level in return air duct of RCS building and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact (programmable) to the PLC. Radiation data will be displayed at controller and on the HMI, operator will set two set-points (High and High-High) and when set point are reached, alarm will be displayed. Set-points will be operator adjustable.

Model – Pylon 'CRM-1' continuous active radon monitor.

Range - 20 – 200,000 pCi/L (Pico-Curies per liter).

High-High radiation alarm will shutdown the HV system and notifies the operator via Auto dialer. Following units will close or shutdown.

1. Buildings supply fan FAN-77-003.
2. Damper DMP-77-002.
3. Duct heater HTR-77-012.
4. Building vent fans FAN-77-001A and B.
5. Damper DMP-77-019.
6. Damper DMP-77-021.

High radiation alarm will alert operator there may be a radiation leak in one of the carbon bed room. A separate exhaust register is supplied to each carbon bed room to extract ventilation air in the event of radon leak. This air is transferred to the RCS system for treatment via the carbon bed drying line. Operator will manually open the system 20 exhaust damper of the affected carbon bed room, close the affected system 77 exhaust damper, and open bypass damper DMP-20-075 and start drying fan FAN-20-003.

Differential pressure transmitter PDIT-FLT-77-002A monitors differential pressure across return air HEPA filter FLT-77-002A and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Differential pressure transmitter PDIT-FLT-77-002B monitors differential pressure across return air HEPA filter FLT-77-002B and it will send 4-20 m A signal (AI) to the PLC, differential pressure will be displayed in the HMI and PLC will log the pressure data when input exceeds high or high-high set point. It will initiate the alarm in the HMI if differential pressure exceeds high or high-high set point. The set point will be operator adjustable in the HMI.

Building Vent Fans FAN-77-001A and FAN-77-001B ventilates the interior spaces of the RCS building.

HMI will have a soft two-position selector switch 'FAN-77-001A - FAN-77-001B'. Operator will select the fan manually. Selected fan discharge damper will open and selected fan will run, other fan will be in standby mode. If running fan stops, it will send alarm to HMI, standby damper will open and standby fan will start automatically. The stopped fans damper will close.

Stand-by fan will stay in operation and operator must press soft RESET button on the HMI to clear alarm. The operator may switch fans over once system upset is corrected by selecting the other fan again.

Each fan is controlled by the local HAND-0FF- AUTO three position switch (HOA-FAN-77-001A or HOA-FAN-77-001B). Switch will send two digital input (2CI) to the PLC. Both fan local switches will be in AUTO position during normal operation.

Hand position - Fan will run, the interlocks are by-passed.

Off position - Fan will stop.

Auto position- Fan will start and stop from the PLC/HMI signal (CO).

HMI will have soft HAND-OFF-AUTO switch.

Soft Auto position – Fan will start-stop based on the run-standby logic. Fan will shutdown on following conditions.

1. High radon alarm from RQIT-RCS-77-001.
2. Respective discharge damper closed DMP-77-019 and DMP-77-021.

In normal operation both fans soft selector switch will be in AUTO position.

Fan motor starter will receive start-stop signal (CO) from PLC and it will send run signal (CI) to the PLC/HMI.

Damper DMP-77-019 is open-close dampers and will isolate building vent fan FAN-77-001A discharge. Damper is controlled from local H-O-A switch HOA-DMP-77-019. Switch will send two digital input signals (2CI) to the PLC. Switch will be in Auto position during normal operation.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI (CO).

HMI will have soft OPEN-CLOSE-AUTO switch.

Soft Auto position – Damper will close/open based on the run-standby logic. Damper will close on following conditions.

1. High radon alarm from RQIT-RCS-77-001.

2. Vent fan shutdown (signal to be bypassed during opening of the damper).

In normal operation damper soft selector switch will be in AUTO position.

Dampers DMP-77-019 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-77-019A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the fan.

Damper DMP-77-021 is open-close dampers and will isolate building vent fan FAN-77-001B discharge. Damper is controlled from local H-O-A switch HOA-DMP-77-021. Switch will send two digital input signals (2CI) to the PLC. Switch will be in Auto position during normal operation.

Hand (open) position – Damper will open, the interlocks are by-passed.

Off (close) position – Damper will close, the interlocks are by-passed.

Auto position- Damper will open and close from the PLC/HMI (CO).

HMI will have soft OPEN-CLOSE-AUTO switch.

Soft Auto position – Damper will close/open based on the run-standby logic. Damper will close on following conditions.

1. High-High radon alarm from RQIT-RCS-77-001.

2. Vent fan shutdown (signal to be bypassed during opening of the damper).

In normal operation damper soft selector switch will be in AUTO position.

Dampers DMP-77-021 control valve (open/close) will receive control signal (CO) from the PLC. Damper limit switch (damper open or close indication) ZS-DMP-77-021A/B will send a two digital input signals (2CI) to the PLC/HMI. Open limit switch will give permissive signal to the fan.

Air flow transmitter FIT-FAN-77-001A/B will monitor air flow discharge from fan FAN-77-001A/B through damper DMP-77-022 to stack and it will send 4-20 m A signal to the PLC, flow rate will be displayed on local panel and in the HMI and PLC will log the flow data at _____ seconds interval.

Radiation transmitter RQIT-RCS-20-001 (Government Furnished Equipment) monitors radiation level in first floor of RCS building and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact (programmable) to the PLC. Radiation data will be displayed at controller in the HMI, operator will set two set-points

(High and High-High) and when set point are reached, alarm will be displayed. Set-points will be operator adjustable.

Model – Pylon 'CRM-2' continuous passive radon monitor.

Range - 4 – 1,000 pCi/L (Pico-Curies per liter).

Radiation transmitter RQIT-RCS-20-002 (Government Furnished Equipment) monitors radiation level in second floor of RCS building and it will send pulse signal (1.3 pulse/pCi/L/minute) and High-High alarm contact (programmable) to the PLC. Radiation data will be displayed at controller in the HMI, operator will set two set-points (High and High-High) and when set point are reached, alarm will be displayed. Set-points will be operator adjustable.

Shutdown exhaust fan on High/High alarm from RQIT-RCS-20-001 or RQIT-RCS-20-002. Close damper DMP-77-002 and DMP-77-019 on DM-R-77-021.

Model – Pylon 'CRM-2' continuous passive radon monitor.

Range - 4 – 1,000 pCi/L (Pico-Curies per liter).

Shutdown exhaust fan on High/High alarm from RQIT-RCS-20-001 or RQIT-RCS-20-002. Close damper DMP-77-002 and DMP-77-019 on DM-R-77-021.

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Appendix I

SILOS 1 AND 2 ACCELERATED WASTE RETRIEVAL PROJECT
REMEDIAL DESIGN PACKAGE
RESPONSES TO REGULATORY AGENCY COMMENTS

GENERAL COMMENTS

SYSTEM DESIGN DESCRIPTION

Commenting Organization: U.S. EPA
Section #: NA Page #: NA Line #: NA
Original General Comment #: 1
Comment: The AWR project involves the retrieval and storage of K-65 materials from Silos 1 and 2 and the potential for elevated radiation doses to workers. It has been previously mentioned that the estimated contact exposure rate on the side of a tank transfer area (TTA) tank is 600 mR/hour. If this is correct, then an individual standing at the center of the four TTA tanks could experience an exposure rate in excess of 2000 mR/hour. Such exposure rates are of concern when considering U.S. DOE's administrative dose limit of 500 mrem/year for workers.

The AWR project is critical for ensuring the eventual success of K-65 material treatment. The design and operation of AWR and the TTA should ensure quick recovery from unanticipated downtimes or events and avoid situations where project recovery is hampered due to worker health and safety issues and poor facility configuration and design. U.S. DOE should ensure that the AWR and transfer tank area (TTA) design and facility configuration minimizes the potential for worker exposure during operations, maintenance, and accident scenarios to the extent possible.

Considering the importance of the AWR project and the severe consequences in the event of failure, it is recommended that the AWR design undergo independent review, and possible pre-review by those who would comprise the Operational Readiness Review team. independent review should help ensure that the AWR and TTA facilities are designed and operated in conformance with applicable DOE orders and directives, ensure protection of the public health and safety, especially worker safety, and ensure that TTA can support the eventual K-65 material treatment.

Response: The AWR facilities are designed in accordance with applicable design codes and ALARA engineering practices. The contact dose of 600 mR/hr is applicable only at the surface of the TTA tanks. The tanks are enclosed in a sealed concrete vault to provide both shielding and isolation from human exposure. In addition, the TTA is designed so that all required operation and maintenance activities can be performed on the upper deck, above the shield wall; no personnel entry into the area adjacent to the tank walls is necessary.

Design documentation for the AWR project undergoes extensive independent review, including review by the Silos Projects Critical Analysis Team. Internal Fluor Fernald review includes review by personnel with expertise in planning and implementation of Operational Readiness Review (ORR) activities.

Commenting Organization: U.S. EPA
Section #: NA Page #: NA Line #: NA
Original General Comment #: 1
Comment: The text states that the entire system for the AWR project will be automated; however, no loop diagrams or process and instrumentation drawings are included in the work plan. The text refers to motorized valves, motorized dampers and other controls; however, no drawings are included to show how

the system will work or what is being controlled manually, automatically, or by other means. The work plan should be revised to include diagrams and drawings, as well as a full description of system operations.

Response: The entire AWR system is designed to be fully automated. Detail on these controls is provided in the Process Control Plan (Section 2.2 of the RD Package)

Commenting Organization: U.S. EPA
Section #: NA Page #: NA Line #: NA
Original General Comment #: 2
Comment: The text states that closed-circuit television (CCTV) will be used to inspect various activities inside the silos and tanks. It is not clear if the proposed system will work, because activities in these enclosed environments might be obscured by water, mist, and vapor. Additionally, the camera lenses need to be cleaned periodically to remove condensation and dirt. The work plan should be revised to discuss these potential problems and to include a contingency plan for resolving them should they occur. According to the process flow drawings, no CCTV cameras are to be located in the secondary enclosures.

Response: The AWR camera system is specifically designed for use in past practice sluicing operations. Similar camera systems from the same designer have been used successfully in past practice sluicing operations in at both the Oak Ridge and Hanford sites.

Commenting Organization: U.S. EPA
Section #: NA Page #: NA Line #: NA
Original General Comment #: 3
Comment: The text does not discuss grounding requirements or lightning protection for the AWR project system. These elements should be included in the system design.

Response: Grounding requirements are addressed in Section 16 of the Construction Specifications.

Commenting Organization: U.S. EPA
Section #: NA Page #: NA Line #: NA
Original General Comment #: 4
Comment: The text contains numerous typographical errors. Also, the text is inconsistent in discussing voltage requirements for various electrical components such as 115 volts (V) versus 110V, 480V versus 460V, and so on. The text should be revised to eliminate these errors and inconsistencies.

Response: Typographical errors have been corrected. The reference to 460, 480, 110,120 voltages are correct and consistent. 480/120 are nominal power system voltages . 460/115,110 are apparatus nameplate voltages. See (IEEE 141(section 3.4)).

SPECIFIC COMMENTS

SYSTEM DESIGN DESCRIPTION

Commenting Organization: U.S. EPA
Section #: 2.2.3.1 Page #: 5 Line #: NA
Original Specific Comment #: 1
Comment: The text states that three manways in each silo will be modified for deployment of the silo waste retrieval system (SWRS); however, no details on how these manways will be modified are provided. Foster Wheeler Environmental Corporation indicated at a meeting held on February 8, 2000, that the manways will be enlarged. Therefore, the text should be revised to discuss how the manways would be enlarged for deployment of the SWRS.

Response: Detail on accomplishing the necessary silo penetrations is provided in the Silo Penetration Plan (Appendix E of the RD Package)

Commenting Organization: U.S. EPA
Section #: 2.2.8 Page #: 7 Line #: NA
Original Specific Comment #: 2
Comment: The text states "that the sluicing jet, from time to time, will impinge upon and impact the retrieval pump that is able to withstand the jet during operation." If the sluicing jet can impinge upon the retrieval pump, it is also possible that the jet can impinge upon the wall of the silo. The text should be revised to discuss this possibility and to evaluate whether there will be any negative effect if the silo wall is impinged upon by the sluicing jet.

Response: The sluicing jet is designed to provide a maximum nozzle discharge pressure of 200 psi . The jet will have no negative effect on the integrity of the concrete walls of the silos.

Commenting Organization: U.S. EPA
Section #: 4.1.2.3 Page #: 17 Line #: NA
Original Specific Comment #: 3
Comment: The text states that a progressive cavity pump will be used for removal of the slurried materials. It is not clear why this type of pump was selected. The slurry could contain gravel and other debris small enough to pass through the a strainer basket with half-inch openings, and such debris could damage the Buna-n stator. For slurry pumping, a recessed-impeller, vortex pump is typically used. Submersible pumps of this type are available from a number of manufacturers. The text should be revised to either justify the selection of the progressive cavity pump or propose the use of a vortex or equivalent type of pump instead.

Response: Progressive cavity pumps are routinely used for pumping heavy slurries in the mining and food industries. They are capable of developing high head and flows with efficiencies typically higher than centrifugal type pumps used with slurries. The particular slurry pump selected for the AWR project is capable of pumping slurries at flow rates of over 500 gpm compared to the 330 gpm required for the silos. This allows the pump to operates at extremely low speeds (220 rpm) compared to 3500 rpm likely needed for a centrifugal type pump that would develop the required head. This low speed translates to low wear for this application. Additionally, the particular model of progressive cavity pump selected for the AWR project will pump up to 2" diameter solids, even though the screen size on the inlet will limit the particle size to less than ½" diameter. The progressive cavity pump manufacturer, Seepex, estimates that all pump parts, including the rotor and stator, should operate 18 to 24 months without the need of repair.

Commenting Organization: U.S. EPA
Section #: 4.2 and 4.2.1 Page #: 21 and 25 Line #: NA
Original Specific Comment #: 4
Comment: The text discusses the radon control system and refers to redundant recirculation fans FAN-20-001A and FAN-20-001B as well as a number of dampers, filters, desiccant drying systems, and carbon beds. However, Diagrams No. 10FMD002 and 10FMD003 are not consistent with the text. The dampers shown on these diagrams are not labeled, and the recirculation fan FAN-10-001 shown on the diagram is not mentioned in the text. Also, it is not clear how a damper installed on the exhaust duct for the silo will help maintain negative pressure inside the silo. Normally, a damper is used on an inlet to restrict the flow of air into a controlled area. The text and diagrams should be revised to address these issues.

Additionally, it is not clear how a negative pressure of -0.1 inch of water will be maintained inside the silo given the constantly changing volume of materials inside the silo. No provision is made to compensate fur fluctuating volumes of liquids and silos in the silo. Typically, during sluicing operations, a volume of water

is introduced into a silo displacing an equivalent volume of gas. Later, the slurry is pumped out of the silo reducing the volume liquids and solids and increasing the volume of gas. Finally, the water added during the sluicing and slurrying operations contribute to the vapor content of the gas in the silo, increasing the pressure inside the silo. Temperature fluctuations may also affect the maintenance of a negative pressure of -0.1 inch of water inside the silo. The text and the diagrams should be revised to clarify how a negative pressure will be maintained in the silos.

Response: Diagrams 10FMD002 and 10FMD003 are not a part of the Radon Control System (RCS), they are a part of the Full Scale Mockup System (FSMS) located at Silo 4. The System Design Description (SDD) writeup for the RCS refers to System 20 drawings. The RCS will be up and operating in Phase 1 (reduction of radon levels in silos) prior to installation and operation of the FSMS. There will not be a direct connection between the RCS (hot) and the FSMS (cold) equipment since the RCS will have been operating during FSMS initiation. The RCS mockup portion of the FSMS will be minimal and will be used to demonstrate that a vacuum can be pulled on the silos that will allow airflow through the enclosures which will maintain a minimal velocity across openings into the silos. The FSMS will also demonstrate that our control scheme works.

The RCS is operated in Phases 1, 2A, 2B, 2C, and 3. Phase 1 is the radon headspace reduction phase of operation. Subsequent phases of operation are where the sluicing operations are employed. Phase 2A mining Silo 1, Phase 2B mining Silo 2, Phase 2C Silos completed TTA ventilation, Phase 3 mining TTA tanks and ventilating future waste treatment facility.

In Phase 1, control of pressure within the silos is based upon pressure readings within the silos that are used to manipulate supply and exhaust modulating dampers on the silos. Discharge pressure on the recirculation fan and the position of supply dampers on the silos control the makeup air and stack exhaust dampers. The pressure monitors for the silos have a setpoint which is adjustable over a predetermined range. During Phase 1, this target setpoint will be –0.1 inches w.g. If this setpoint is unachievable, it will be reset to a reduced vacuum requirement (eg -.001 w.g.) that is influenced by the structural integrity (eg air infiltration through cracks) of the silos. This setpoint is only a target during Phase 1, an operating range of silo pressures from 0 to –1.0 inch w.g. is acceptable.

Subsequent phases will control the pressures within the mined silo by using the same pressure monitors employed in Phase 1, only the silo exhaust dampers will be modulated, supply dampers on the enclosures will be set. The recirculation supply damper on the silo being mined is closed and three supply dampers, one on each enclosure, are used to provide air to the silo undergoing mining. This method of operation will ensure a negative pressure within the silo. Dampers installed in the exhaust duct will open to allow for exhausting greater volumes of air thus affecting the pressure within the silos. The range of negative pressures achievable and the permissible velocities across the silo openings will be determined and verified during FSMS operations. Again, as in Phase 1, the setpoints are adjustable and the operating range is between 0 and –1.0 inch w.g.

Pressure variations within the silos based upon sluicing to, pumping from, and/or temperature variations will be detected by the pressure monitors within the silos and will be relieved by use of the modulating dampers and the variable speed fan system.

Commenting Organization: U.S. EPA
Section #: 4.4.9 Page #: 35 Line #: NA
Original Specific Comment #: 5
Comment: The text states that sampling of waste residue will be conducted by continuously collecting a sample at a rate of 1 gallon for every 1000 gallons transferred. However, the text further states that at a maximum flow rate (transfer rate) of 350 gallons per minute, the sampler will take a 200 cubic-centimeter

sample about every 9 seconds. This statement implies that the sampling will not be continuous, but will involve collecting composite samples composited from a number of grab samples. The text should be revised to clarify the type of sampling that should be conducted.

Response: The sampling scheme has been modified from what was reflected in the January 2000 draft RD Package. In the new scheme, samples will be taken directly from the TTA tanks. Detail on the sampling approach is provided in the Sampling and Analysis Plan (Section 3 of the RD Package).

Commenting Organization: U.S. EPA
Section #: 5.1.4.4 Page #: 55 Line #: NA
Original Specific Comment #: 6
Comment: The text states that the motor starter will be used to provide "for normal shutdown or soft stop shutdown." It is not clear how a motor starter can provide a soft-stop shutdown. The text should be revised to clarify this matter.

Response: The use of the term "soft-stop" may be confusing and will be corrected. The term "soft-stop" is used to mean the PLC stops the equipment that is connected to the "soft-stop" switches. The Sluicer, Slurry, Decant, and High Pressure Water Pumps equipment enclosures all have E-stop switches which are hardwired to certain equipment items (i.e. hoists, cable reels, etc.) that operating personnel will have direct contact with. The PLC monitors the E-stop switches and will back up the hardwire stop command with soft-stop commands from the PLC. There is also a "soft-stop" switch in the control room to allow rapid stop of equipment project wide.

The term "soft-stop" was a descriptive term meaning the PLC was issuing the stop commands. It had nothing to do with motor starters. Future revisions will use the term "Q-stop" (quick stop) instead of "soft-stop" for this type of operation.

Commenting Organization: U.S. EPA
Section #:5.1.5.1 Page #: 56 Line #: NA
Original Specific Comment #: 7
Comment: The text states that the slurry pump speed will be controlled by an operator in the control trailer. The text further states that the "ultrasonic level sensor is mounted above the slurry pump intake to determine the level of slurry present at the pump intake. If the slurry amount or level is low, the sensor will detect the low level and turn the slurry pump off." The text should be revised to clarify the fact that an ultrasonic level sensor can detect only the level of slurry, not the amount of slurry. Additionally, the ultrasonic level sensor can be used to control the slurry pump's speed by maintaining the slurry at a preset level above the minimum, or at a "pump stop" level. Because the operator will not be able to see inside the tank and because CCTV cameras may become obscured, an automatic level control system should be used to avoid unnecessary pump shutdowns and provide for uninterrupted pumping of slurry. The text should be revised accordingly.

Response: It has been planned to provide both open loop and closed-loop feedback for the control of slurry level inside the pump can. Under all operating schemes the slurry pump will still shutdown when the level of slurry inside the pump can drops to the shutoff setpoint. Additional detail on control of the retrieval process is provided in the Process Control Plan (Section 2.2 of the RD Package).

Commenting Organization: U.S. EPA
Section #: 5.1.5.3 Page #: 56 Line #: NA
Original Specific Comment #: 8
Comment: The text states that "the motor starter provides a method to remove power from the motors for normal shutdown or soft stop shutdown." Soft-stop shutdown is typically provided by a variable-speed drive

(a variable-frequency drive), not a motor starter. A motor starter can only connect the motor to or disconnect the motor from a power supply. The text should be revised to reflect this fact. In addition, it is not clear exactly where the lockable disconnect switch will be located. The text or drawings should be revised to specify the location of the lockable disconnect switch.

Response: The use of the term "soft-stop" may be confusing and will be corrected. The term "soft-stop" is used to mean the PLC stops the equipment that is connected to the "soft-stop" switches. The Sluicer, Slurry, Decant, and High Pressure Water Pumps equipment enclosures all have E-stop switches which are hardwired to certain equipment items (i.e. hoists, cable reels, etc.) that operating personnel will have direct contact with. The PLC monitors the E-stop switches and will back up the hardwire stop command with soft-stop commands from the PLC. There is also a "soft-stop" switch in the control room to allow rapid stop of equipment project wide.

The term "soft-stop" was a descriptive term meaning the PLC was issuing the stop commands. It had nothing to do with motor starters. Future revisions will use the term "Q-stop" (quick stop) instead of "soft-stop" for this type of operation.

Lockable disconnects are provide at the local control cabinets located on the Sluicer, Slurry, and Decant, and High-Pressure Water enclosures.

Commenting Organization: U.S. EPA
Section #: 5.1.6.4 Page #: 58 Line #: NA
Original Specific Comment #: 9
Comment: The text states that "the soft stop cable is intended to rapidly stop motor-driven equipment." Typically, an emergency stop it a safety feature that disconnects the power to a motor; it therefore cannot provide a soft stop. The text should be revised to reflect this fact.

Response: See response to Specific Comment 8.

Commenting Organization: U.S. EPA
Section #: 5.1.6.11 Page #: 59 Line #: NA
Original Specific Comment #: 10
Comment: The text states that "the enclosure is equipped with a sun shield to reduce the heat load during the summer conditions." The sun shield could be eliminated if the enclosure were to be mounted on the north facing wall. This adjustment to the design should be considered. Furthermore, heaters are used inside electrical cabinets to prevent condensation, not to maintain a "warm internal cabinet temperature in cold weather conditions" as the text states. The text should be revised to clarify this fact.

Response: The Sluicer and Slurry control cabinets are mounted generally in the southern location of the enclosures. This design is necessary due to space limitations. The cabinets are equipped with air cooler devices to maintain internal cabinet operating temperatures within acceptable temperatures during the summer. The cabinets are also equipped with cabinet heaters to maintain warm cabinet temperatures during the winter. The heaters are required to maintain the cabinet temperature above the minimum operating temperature for the PLC data collection equipment

Commenting Organization: U.S. EPA
Section #:5.6.1.11 Page #: 59 Line #: NA
Original Specific Comment #: 11
Comment: The second sentence of paragraph 2 starts with the phrase "the equipment includes..." but does not list any equipment. The text should be revised to identify what equipment is included.

Response: The text has been revised to identify the equipment.

Commenting Organization: U.S. EPA
Section #: 5.1.7.2 Page #: 60 Line #: NA
Original Specific Comment #: 12
Comment: The text states that "the power supply provides power to a limited number of sensors and actuators" and that "sensor and actuator requirements may demand additional power supplies." It is not clear where these additional power supplies will be located or who will be providing them. The text should be revised to clarify this matter. Also, if the power requirements of the selected equipment are not known at this time, the design for the control logic and for equipment control cannot be complete. The text should be revised to explain how this deficiency will be addressed.

The design and identification of control equipment needs has been completed; no additional power supplies are required.

Commenting Organization: U.S. EPA
Section #:5.1.8.2 Page #: 61 Line #: NA
Original Specific Comment #: 13
Comment: The text states that a motor starter will be used to "remove power from the motors for normal shutdown or soft stop shutdown." Typically, motor starters are used to start and stop pump motors; however they cannot provide a soft stop. A soft stop can be provided by a variable-frequency controller; however, the proposed decant pumps are single-speed pumps and therefore a soft stop cannot be provided. The text should be revised to reflect these facts.

Lockable disconnects are provided at all local control cabinets. For clarification of the use of soft stops, see the response to specific comment 8

Commenting Organization: U.S. EPA
Section #:5.1.8.3 Page #: 61 Line #: NA
Original Specific Comment #: 14
Comment: The text states that the enclosure for the decant pump controls will not require heat or air conditioning. Air conditioning will not be required; however, a strip heater should be installed in each control panel located outdoors to prevent condensation inside the control panel. The text should be revised accordingly.

Response: A strip heater will be added to the decant system control panel

BERM EXCAVATION PLAN

Commenting Organization: U.S. EPA
Section #:1.4 Page #: 2 Line #: NA
Original Specific Comment #: 15
Comment: The text states that soil will be continuously surveyed for the presence of contamination during excavation. Separate documents should be submitted to detail how this survey can be performed with

adequate sensitivity and accuracy in the presence of the gamma interference (commonly called radioactive "shine") from the K-65 material in the silos,

SAMPLING PLAN

Commenting Organization: U.S. EPA
Section #: 2.3 Page #: 6 Line #: NA
Original Specific Comment #: 16
Comment: The text states that method blanks will be used to monitor for the presence of interfering substances. A blank sample prepared using a new batch of reagent should be analyzed before that batch is accepted for use on actual samples. In addition, each new lot of spiking solution for laboratory control samples (discussed in Section 2.2.1) and for matrix spikes (discussed in Section 2.2.5) should be analyzed before the lot is accepted. Section 2.3 should be revised to incorporate these practices.

Commenting Organization: U.S. EPA
Appendices C and E Page #: NA Line #: NA
Original Specific Comment #: 17
Comment: Appendices C and E present procedures for collecting water and air samples, respectively. The certified-for-construction drawings, which are not yet available, should incorporate the necessary taps, sample ports, and working space for the sample activities discussed in these appendices.

Commenting Organization: U.S. EPA
Appendix E Page #: NA Line #: NA
Original Specific Comment #: 18
Comment: The text states that samplers should "take intermediate readings of flow rates" and other relevant parameters. The text should specify the frequency for intermediate readings, such as once every minute, hour, or day.