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PROCESS DESCRIPTION DOCUMENT FOR THE ACCELERATED WASTE RETRIEVAL PROJECT

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Revision 0

FERNALD
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Revision Sheet

Revision	Date	Pages Affected	Reason for Revision
A	5/15/02	ALL	ISSUED FOR REVIEW AND APPROVAL
B	5/29/02	ALL	INCORPORATED CLIENT COMMENTS
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ACRONYMS

AC	Alternating current
API	American Petroleum Institute
AWR	Accelerated Waste Retrieval
AWWA	American Water Works Association
BOP	Balance of Plant
CATS	Conditioning and Transfer System
CCTV	closed circuit television
CFR	*Code of Federal Regulations*
DCS	distributed control system
D&D	decontamination and demolition
DOE	U.S. Department of Energy
EMMA™	Easily Manipulated Mechanical Arm
FEMP	Fernald Environmental Management Project
FSMS	Full Scale Mock-Up System
FWENC	Foster Wheeler Environmental Corporation
HEPA	high-efficiency particulate air
HMI	human machine interface
I/O	input/output
Jacobs	Jacobs Engineering
OEPA	Ohio Environmental Protection Agency
PLC	programmable logic controller
RCS	Radon Control System
RD	remedial design
ROV	Remotely Operated Vehicle
SWRS	Silo Waste Retrieval System
TTA	Transfer Tank Area
TWRS	TTA Waste Retrieval System
USEPA	U.S. Environmental Protection Agency
UPS	uninterruptible power supply

1.0 INTRODUCTION

Silos 1 and 2 are located at the U.S. Department of Energy (DOE) Fernald site near Cincinnati, Ohio. The silos contain K-65 material, a residue that contains radionuclides, including radium (the primary contaminant of concern), which was generated in processing high-grade uranium ores.

As part of the remediation of Silos 1 and 2, silo material will be removed and staged into a shielded and ventilated storage tank system. Future plans call for the transferring the K-65 material from the Transfer Tank Area (TTA) to the Silos 1 and 2 Remediation Facility (currently in final design) for treatment prior to off-site disposal.

The current Fernald baseline schedule calls for the Silos 1 and 2 Remediation Facility to be constructed concurrently with the Accelerated Waste Retrieval (AWR) Project. The current schedule also reflects some degree of operational overlap between the operating of the AWR process and the Silos 1 and 2 Remediation Facility process; however, the Silos 1 and 2 Remediation Facility Project is not within the scope of the AWR Project or this document.

The AWR technical objectives and criteria are defined in "The AWR Technical Requirements Document Doc. No. 40710-RP-001." In December 2000, the Foster Wheeler Environmental Corporation (FWENC) prepared a final design report, supporting the AWR Technical Requirements Document. Based upon this design a Remedial Design (RD) Package was submitted to and subsequently approved by the U.S. Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA).

Subsequent to the December 2000 AWR Final Design submittal, the FWENC's Contract was terminated and Fluor Fernald acquired the services of Jacobs to review, modify, and optimize the existing FWENC design in an effort to reduce project risk and enhance the probability of the AWR Project's success.

Based upon the Jacobs AWR design optimization efforts, a modified AWR design description has been prepared. The objectives of this document are the following:

1. Define the relevant technical baseline modifications;
2. Define the relevant AWR Design Basis modifications;
3. Define the major changes to the FWENC December 2000 Final Design as defined in the RD Package; and
4. Generally describe the modified AWR Design in terms of the processes and equipment needed to meet the applicable AWR technical baseline requirements.

2.0 DEFINITION OF AWR MODIFICATIONS

Modifications to the AWR Technical Baseline have been made as a result of the design optimization process and to correct design deficiences in the FWENC Final Design package discovered during the Due Diligence review process. Accordingly these modifications have generated changes in the AWR Design Basis and ultimately the physical AWR design. These changes are defined below. The defined changes are in addition to or in clarification of those listed in the Fernald Environmental Management Project (FEMP) Baseline Closure Plan, Volume VII: Silos Project Silos 1 And 2, AWR Project, Change Proposal (40000-PL-0011), Revision 2, December 2001.

2.1 BASELINE SCHEDULE MODIFICATIONS

The Fernald Baseline Schedule has been modified to reflect concurrent construction of the AWR Facilities and the Silos 1 and 2 Stabilization Facility. The baseline schedule also reflects concurrent operation of both facilities during the later phases of the AWR Project.

2.8.1 Resulting Design Basis Changes

The AWR design has been modified to include the capability to transfer material from either Silo 1 or Silo 2 to any of the four TTA tanks while transferring sluicing material from any TTA tank to the Silos 1 and 2 Remediation Facility.

2.8.2 Resulting Physical Design Changes

1. A fixed bridge will be constructed over each silo to support waste retrieval operations.
2. Each bridge will be provided with two sluicing cannon modules and a slurry/decant pump module.
3. Two sluicing cannon modules and a slurry/decant pump module will be provided on the TTA deck above each TTA tank.

2.2 SILO CAP REMOVAL

In the FWENC design the 30-ft-diameter plywood and steel framing silo caps were to be left in place during Silos Waste Retrieval System (SWRS) activities.

However, having these plywood caps creates technical challenges with the Silo Waste Retrieval equipment risers. Therefore, to mitigate this technical risk the silo caps will be removed prior to the installation of the SWRS equipment. The caps are being removed to expose the concrete silo domes to facilitate in installing new silo equipment access risers.

2.2.1 Resulting Design Basis Changes

The AWR design has been modified to include the removal of the 30-ft plywood and steel framing caps.

2.3 POSTPONEMENT OF HEEL MATERIAL AND DISCRETE OBJECT REMOVAL FROM THE SILOS

Removal of discrete objects and debris from the silos has been removed from the AWR scope. Bulk waste retrieval operations will continue until the slurry pumps can no longer be operated. Heel material is defined as material that cannot be readily removed using the AWR Past Practice Sluicing Technology. The discrete objects and heel material will be removed using more direct techniques than the past practice sluicing technology. The heel material will be removed during AWR safe shutdown activities after the completion of bulk waste retrieval. The specific design of the heel removal system will be developed based upon the experience and actual data on the amount and condition of discrete objects and heel material gained during bulk waste retrieval.

2.3.1 Resulting Design Basis Change

No provisions are provided to remove the heel material or discrete objects from the silos during the bulk waste retrieval phase of the AWR Project. The current concept for heel removal being considered by Fluor Fernald and DOE EM-50 involves the use of a Remotely Operated Vehicle (ROV) to move heel material into the Silo Sump Pit, from which it would be pumped to the TTA. The specific details of discrete object and heel removal and final decontamination of the silos will be finalized based on information and experience gained during bulk waste retrieval and will be defined in the safe shutdown documentation submitted for regulatory review.

2.3.2 Resulting Physical Design Changes

1. The conditioning and transfer system (CATS) designed for heel removal and consisting of the Silo (Waste) Retrieval End Effector, a hose bundle, a jet pump, and the slurry pump heel attachments is eliminated from the design.

2. The debris removal system is eliminated from the AWR design.

3. The Easily Manipulated Mechanical Arm (EMMA) is eliminated from the AWR design because its primary function was removal of discrete objects and to assist with manipulating the silo waste retrieval end effector during the CATS heel removal activities.

2.4 POSTPONEMENT OF HEEL MATERIAL AND DISCRETE OBJECTS FROM DECANT SUMP

The Decant Sump Tank is located underground and just west of and between the silos. The decant sump is known to contain a small quantity of residual sludge material. Similar to the situation involving the silo heel material, this residual sludge material would be very difficult to remove using past practice sluicing; therefore the decant sump residual material is projected to be a small quantity and will be removed during silo decontamination and demolition (D&D) activities. The details of decant sump tank solids removal will be defined in the Safe Silo D&D Project shutdown documentation submitted for regulatory review.

2.4.1 Resulting Design Basis Change

No provisions are required in the AWR design basis to remove the residual sludges from the Silo Decant Sump. The AWR design basis does require that an automated level control and liquid removal system be placed in the decant sump during SWRS activities.

2.4.2 Resulting Physical Design Change

1. The Decant Waste Retrieval System is eliminated from the AWR design.

2. As described in detail in Section 3.2, decant sump tank liquid level instrumentation and capability to automatically pump out accumulated liquid is maintained in the AWR design.

2.5 FULL SCALE MOCK-UP SYSTEM

The Full Scale Mock-Up System (FSMS) has been eliminated from the scope of the AWR Project. However, a cold test loop involving the testing and optimization of AWR process equipment has been added to the scope of the AWR Project. The cold test loop is intended to provide data similar to that expected from the FSMS.

2.5.1 Resulting Design Basis Change

1. No provisions are required for a full-scale mock-up of the AWR process at FEMP.

2. A cold testing system to demonstrate the key AWR design parameters and process equipment must be developed.

2.5.2 Resulting Physical Design Change

1. The FSMS, which includes all the process equipment associated with Silo 4, is eliminated from the AWR design.

2. A cold testing system to demonstrate the key AWR design parameters and process equipment must be developed. The key process parameters will include: materials of construction, deposition velocities, material conveying properties, and design approach. Key process equipment will include the sluicing cannons, slurry pumps, slurry instrumentation, and valves.

2.6 MODIFICATION OF AWR WASTEWATER MANAGEMENT STRATEGY

2.6.1 The Resulting Design Basis Change

The previous design basis specified treating AWR wastewater by one of the following three methods:

- Ultra-filtration followed by discharge to the Advanced Wastewater Treatment (AWWT).

- Hold-up of wastewater for radon decay followed by discharge to AWWT.
- Treatment of wastewater via skid-mounted ion exchange and filtration followed by discharge to the AWWT.

The modified Wastewater Management Plan specifies the following methods of wastewater dispensation.

- During Radon Control System (RCS) Phase I prior to the availability of the TTA tanks, condensate from the dehumidification system is stored in the condensate hold-up tanks for radon decay. Following radon decay the condensate is transferred to the AWWT for further treatment. The design of the condensate hold-up tanks is based on a radon decay stay time of 20 days and a condensate flow rate from desiccant dryers of 0.08 gpm see RCS Phase 1 Mass Balance Table for more information.
- At the time the TTA tanks become available for use condensate is pumped to the TTA tanks for use during sluicing operations.
- Excess water from bulk waste retrieval will be transferred to the Silos 1 and 2 Remediation Facility for storage pending use in the Silos 1 and 2 treatment process, or sampling and discharge to the AWWT.

2.7 THE DESIGN CAPACITY OF THE RCS HAS INCREASED TO 2,000 SCFM

2.7.1 Resulting Design Basis Change

The components comprising the RCS must be sized to adequately treat 2000 scfm at the design conditions of 100 percent relative humidity and 95°F. The 2000 scfm capacity will be utilized if expanded radon treatment is identified as necessary to support concurrent operation of bulk waste retrieval and the Silos 1 and 2 Remediation Facility.

2.7.2 Resulting Physical Design Change

The ducting and fans have increased in size to accommodate a process flow rate of 2,000 scfm. The drying system and the discharge high-efficiency particulate air (HEPA) filters have been reconfigured to allow parallel operation at 2,000 scfm.

2.8 THE DUCT HEATERS HAVE BEEN ELIMINATED FROM THE RCS DESIGN

2.8.1 Resulting Design Basis Change

As a result of reevaluation of both the original assumptions regarding the risk of ignition of the carbon, and the need to use heated air in order to provide adequate drying, the decision to eliminate the duct heaters from the RCS design. Reevaluation by an independent fire hazard analysis expert predicted an auto-ignition temperature for the carbon, under the conditions expected in the RCS, significantly lower than what was previously assumed (and lower than the drying temperature specified in the design). The modified design utilizes unheated, dried air from the desiccant dryer system rather than heated air to provide necessary drying.

2.8.2 Resulting Physical Design Change

Since the RCS design includes redundant desiccant dryers, as well as demisters upstream of the beds to dry all air entering the carbon beds, buildup of excessive moisture, and the need to dry a bed is not expected to occur frequently. Radon monitors and moisture monitors will be used to monitor the condition and effectiveness of each bed. Based on the data from these monitors, the need to regenerate a bed will be identified and initiated. Regeneration will be accomplished by isolating the bed requiring drying and recycling dried air from the desiccant drying system through the bed until is has been sufficiently dried. The RCS provides sufficient excess carbon adsorption capacity maintain specified emission limits while the impacted carbon bed is being dried.

3.0 SYSTEMS IDENTIFICATION AND DESCRIPTIONS

This section provides brief descriptions of the operational strategy and major process systems that are associated with successfully completing the AWR Project operations. While Silos 1 and 2 contain two distinct layers of material that must 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-in. deep in the center of the silo and 3-ft 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 material is over 20 ft deep. The primary contaminant associated with the K-65 waste material is radium and radon, which is produced by the radioactive decay of radium.

The AWR Project baseline consists of four distinct objectives:

Objective 1: Construct a radon treatment system to reduce the concentration of each of the silos' headspace before other AWR activities begin and to maintain safe radon concentrations during all AWR activities.

Objective 2: Retrieve the K-65 materials from the silos and transfer the waste material to a safe storage area.

Objective 3: Stage the K-65 material in the TTA until it is transferred to the Silos 1 and 2 Remediation facility.

Objective 4: Retrieve the K-65 material from the TTA facility and transfer the K-65 material to the Silos 1 and 2 Remediation Faciltiy.

To accomplish these project objectives in accordance with the current technical baseline the AWR Project is provided with the major process systems listed below.

RCS – The RCS controls and reduces radon concentrations in the silos and the AWR process facilities. The RCS consists of a ducting system, an air chilling/drying system, an activated carbon system, HEPA filtration, controls, and a monitored stack.

SWRS – The SWRS utilizes a technique referred to as past practice sluicing to retrieve and transfer material from the silos. Past practice sluicing utilizes a low to medium pressure (50 to 200 psi), high volume (200 to 350 gpm) liquid stream to dislodge, slurry, and convey waste material to the intake of a transfer pump. The transfer pump is used to convey the slurried material to a storage facility. The AWR Project utilizes two 300-gpm sluicing nozzles and one 350-gpm centrifugal slurry pump on each silo. The sluicing nozzles and the slurry pumps are housed in sealed steel structures. The steel structures are supported on fixed bridge structures constructed over each silo. The sluicing nozzles are located approximately 50 ft apart. The slurry pump is located between the sluicing nozzles. The sluicing nozzles and slurry pumps enter the top of the silos through engineered penetrations. The sluicing nozzles and slurry pumps are designed to allow their placement through the entire vertical profile of the silos.

TTA System – The TTA system consists of four 750,000-gal American Petroleum Institute (API) 650 carbon steel storage tanks located in a shielded concrete vault. Each of the tanks is ventilated by the RCS for radon control. The tank vaults are provided with leak detection and a means to remove liquid wastes. The K-65 material will be stored in the TTA until it is transferred to the Silos 1 and 2 Remediation facility.

Transfer Tank Area Waste Retrieval System (TWRS) – In the future, the TWRS will retrieve the K-65 from the TTA and transfer it for processing at the Silos 1 and 2 Remediation Facility. Past practice sluicing will be utilized to transfer the waste from the TTA in much the same manner in which it is removed from the silos. Two 300 gpm sluicing nozzles and one 350-gpm slurry pump are provided for each TTA tank. The sluicing nozzles and slurry pumps are housed in sealed steel structures (equipment modules). The design of the sluicing and slurry systems comprising the TWRS are identical to those in the SWRS operation. During SWRS, the TWRS slurry pumps are used to provide sluicing water to the silo sluicing nozzles. Supernatant resulting from the settling of solids within the TTA tanks is used to supply sluicing water.

3.1 SILOS 1 AND 2 WASTE RETRIEVAL SYSTEM

The SWRS retrieves K-65 material, BentoGrout™, and residues from the silos and transfers them to the transfer tanks. Prior to the initiation of SWRS activities the plywood and steel caps are removed from the silo structures to expose the silo's concrete surface for ease of equipment installation. Past practice sluicing techniques are used to recover the majority of waste in the silos. Three video cameras with lights that are deployed through risers located in the silo roof provide the global view required to maneuver and control in-silo equipment during waste retrieval and assessments.

The SWRS main systems and components used with each system are:

- Silo 1, Sluicer 1
- Silo 1, Sluicer Module No. 1
- Silo 1, Sluicer 2
- Silo 1, Sluicer Module No. 2
- Silo 1, Slurry/Decant Pump
- Silo 1, Slurry/Decant Pump Module
- Silo 1, Slurry transport piping
- Silo 1, Closed-Circuit Television (CCTV) Video Camera and Light, Nos. 1, 2, and 3

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- Silo 1, High Pressure Decontamination Pump
- Silo 2, Sluicer 1
- Silo 2, Sluicer Module No. 1
- Silo 2, Sluicer 2
- Silo 2, Sluicer Module No. 2
- Silo 2, Slurry/Decant Pump
- Silo 2, Slurry/Decant Pump enclosure
- Silo 2, Slurry transport piping
- Silo 2, CCTV Video Camera and Light, Nos. 1, 2, and 3
- Silo 2, High Pressure Decontamination Pump
- Silo Diverter Valves
- Silo Bridge Enclosure
- Silo Decant Sump Tank Sump Pump
- Silo "C" Bridge
- Long Reach Manipulator Tool

Bulk retrieval of the silo waste material is accomplished using two sluicing nozzles and a slurry pump. Each silo has its own dedicated bulk retrieval equipment. The silo slurry pump is located in a module on the bridge over the center riser of the silo. The two sluicing nozzles are located in a module on the bridge over risers inline with the slurry pump along the silo's perimeter at 0° and 180° (co-linear with the pump) and approximately 50 ft apart. The automatic actuators to the systems' control valves are electric and normally controlled from the Control Room. Local control panels provide valve actuator control on the bridge decks. Sluicing liquid is decanted from the TTA tanks and will be supplied by the TTA Slurry Pumps.

Initially, the sluicing nozzle stream(s) are directed as close to the slurry pump inlet as possible to create a slurry pool (approximately 6 ft in diameter by 1.5 to 3 ft 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. The slurry pump also has a high-pressure water jet ring at the pump suction that can assist in breaking up hard material into pumpable slurry. The sluice nozzle then begins cutting a vertical "canyon" into the silo waste, pushing it toward 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. If debris becomes lodged in the inlet screen plate of the slurry pump and cannot be removed by operating the spray ring or by jogging the pump, a Long Reach Manipulator Tool could be manually used to clear away the debris from the pump inlet screen plate. If these activities are not successful, the pump can be raised up into the slurry pump enclosure and the obstruction can be physically removed. After each day's sluicing operations, the slurry line, slurry pump, sluice line, and sluicer are flushed with decant water and then rinsed with domestic water. If plugging occurs during normal operations, the decant water can be redirected to the slurry line to back-flush the plug out of it.

As the waste level in the silo decreases, the slurry pump is periodically lowered further into the tank, until it reaches the small sump in 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 cavitating and minimize plugging.

The pump has a discharge pressure gauge and 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 that the slurry transfer pipeline flow is in the target solids concentration range to prevent plugging. The accuracy of the flow meter at the nominal process solids loading (10 to 15 weight percent [wt%]) and volumetric flow rate (300 to 350 gpm) is estimated at ± 0.11 percent. If the solids wt% increases sharply or indicates an increasing trend, sluice water is injected directly into the slurry transfer line to maintain the target solids content and to help ensure that solids do not settle in the transfer piping by maintaining the pipeline velocity.

The sluicing nozzle is lowered periodically as the waste level is decreased. Lowering the nozzle increases waste mobilization efficiency by attacking the waste at a more direct angle and shorter distance. The total 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 when the sluicing nozzle is not adequate to break up the waste. The slurry pump has a high-pressure spray ring to assist in breaking up the hardened material. Liquid for the spray ring is supplied from the site domestic water systems, using the high-pressure pumps. The operation of the spray ring is being optimized as part of the AWR Cold Loop Test.

3.1.1 Silo Sluicers

Each silo has two sluicers; each sluicer is installed in its dedicated module that is mounted on the bridge. Silo sluicer nozzles are approximately ¾-in. inside diameter and normally operate independently at 200 psi and 300 gpm. This will create a sluicing stream having approximately 140 ft/sec velocity. Total sluicing flow rate will be fixed with a maximum total flow of 300 gpm whether operating one or two nozzles to maintain silo water balance during bulk retrieval.

Optimizing and selecting sluicing nozzle size, flow, pressure, and operating configurations are part of the cold loop testing. Each nozzle is articulated remotely from the Control Room in an automatic or manual mode to allow for either vertical channel cutting or horizontal sweeping as necessary. Each sluicer has a 340° horizontal rotation and 105° vertical rotation capability.

As waste level decreases, the two sluicers also have the ability to be lowered to achieve the proper angle of attack on the waste. Mast sections containing sluicing piping are manually added with the assistance of a hoist to raise and lower the nozzle. The mast hoist in each of the sluicer enclosures accomplishes fine adjustment of either of the main nozzles' elevation. The mast hoist is normally operated from the Control Room but also may be operated locally when adding or removing sections.

3.1.2 Silo Sluicer Enclosures

The sluicing deployment system for the sluicers is housed in a Sluicer Module. The module serves as secondary containment and drains to the silo. The module measures approximately 6 ft by 10 ft by 20 ft high. The enclosure weighs approximately 15,000 lb and has several gloveport panels, an 11-ft by 3-ft access door and a 2-ft by 2-ft 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 sluicer nozzles are removed from the silos they are decontaminated by a high-pressure spray ring and passed through a radiation-monitoring ring. Manual washing with a spray wand occurs through the glove ports as the equipment is removed to ensure that the equipment is properly cleaned. Water to the spray ring and manual spray wand is domestic water and is supplied from the high-pressure decontamination pump. The sluicer module has a large interface opening to allow the sluicing equipment to pass into and out of the silo. During sluicing, the interface opening is covered by a panel.

3.1.3 Silo Slurry Pump

The slurry pump is a centrifugal-style, submersible sump pump. Normal operation of the pump is expected to be approximately 350 gpm and 150 psi during SWRS activities. The impeller and wear components are made of an abrasion-resistant material. A cutter is included ahead of the pump inlet to break up large chunks of material as well as shred plastic and other similar debris, allowing it to be pumped rather than plug or blind over the pump's inlet. A high-pressure spray ring is also mounted ahead of the pump's suction. The agitator and spray ring keep the solids in slurry form as well as help the pump "dig" into the K-65 and BentoGrout™ material. Additionally, a strainer screen plate is mounted ahead of the pump's suction to protect the pump from damaging debris entering it. The pump is supported from a cable and winch system. The pump is variable speed to control and match flows with the other pumps. The drive motor is a super severe duty (Service Factor = 1.35), which would require 480 VAC, 60 Hz, three-phase power. The motor and pump assembly are mounted on a vertical-positioning system that is raised and lowered by an open loop, remotely controlled, single-speed AC drive motor. When the pump is lowered to the bottom of its travel, the assembly is manually secured and another section of mast is installed. A level instrument remotely displays the pumps' elevation. The pump has liquid-level and lower travel-limit instrumentation that indicates when the pump is 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 20,000 lb.

3.1.4 Silo Slurry Pump Module

The slurry pump deployment assembly is housed in a Slurry Pump Module. The module serves as secondary containment and drains to the silo. Currently the module measures approximately 9 ft wide by 18 ft long by 20 ft high. The module has a horizontal-sliding carrier that assists with pump and mast section assembly and stowage. The module has multiple gloveport panels, a 10-ft by 3-ft access door, and a 2-ft by 2-ft pass-through.

The module contains piping and valves needed to support the pumping, flushing, dilution, and decon operations. Valves and piping will include motor operated multi-way ball valves and piping/hoses to direct the flows. The module also contains a spray ring to decontaminate the pump assembly when it is removed from the tank.

The weight of the slurry pump system is supported off the silo bridge platform. The slurry/decant pump system is connected to the silo by a flexible coupling that allows vertical or horizontal bridge platform movement without inducing stresses to the silo. When the slurry pump is retracted from the silo it is decontaminated by a high-pressure spray ring, which is mounted at the bottom of the enclosure. Manual washing with a spray wand and radiation monitoring occur through the gloveports as the equipment is removed to ensure that the equipment is properly cleaned. Water to the spray ring and manual spray wand is potable water from the high-pressure decontamination pumps.

3.1.5 Silo Slurry Transport Pipeline

The slurry transport pipeline is a pipe-in-pipe design that provides secondary containment. The slurry transport pipeline is insulated and heat-traced. The pipeline is also provided with automated systems to detect leaks, monitor pipeline pressures, and measure 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 gravity-draining.

The slurry transport pipeline runs from each of the silo modules to the silo diverter valve enclosure located on the support bridge connecting the two silo bridges. From the valve enclosure the slurry lines run along a pipe bridge to the TTA Building until they terminate at the TTA diverter valve room containment area. The TTA valve enclosure is located centrally to the waste storage tanks. From the valve room the slurry is discharged into the Transfer Storage Tanks. If plugging occurs during normal operations, the decant water to the sluicers is directed into the slurry line to clear the blockage. Capability is provided for forward flushing and back flushing to clear a clogged line. In addition to flushing capability, clean-outs are provided in the transfer piping at intervals of approximately every

80 ft between the Silo Bridges and the TTA. A spare slurry transfer line is also provided that enables operations to continue until the end of the operating period. Pressure gauges located at intervals along the transfer piping are used to determine the location of the blockage.

Once the approximate location of the blockage is pinpointed, using a quick disconnect the line will be flush to remove blockage.

The slurry pump is equipped with an inlet screen plate to minimize the size of debris. Therefore clogs will most likely consist of K-65 and BentoGrout™ material. This material will remain in the pipe and be flushed to the Transfer Storage Tank after the blockage has been cleared.

3.1.6 Silo Bridge

All silo equipment modules, skidded equipment, and piping are supported by a steel bridge structure. The bridge is a fixed "C" shape with each leg of the "C" extending out over each of the silos. Design of the bridge should consider safe access to the modules and other equipment as well as operations and maintenance (O&M) activities.

A containment area enclosure is placed at the center of the bridge. The enclosure contains the piping, valves and/or manifold and hose jumpers, and possibly the sluicer booster pumps needed to support the pumping, flushing, dilution, and decon operations. Valves and piping include motor-operated multi-way valves and piping/hoses to direct the flows. The flanges within these areas are fitted with flange guards to prevent spray from a leaking joint.

3.1.7 Silo Decant Sump Tank

The Decant Sump Tank is located underground and just west of and between the silos. The Decant Sump Tank is carbon steel, 9,000-gal, 18-ft-long, and 9-ft-diameter cylindrical tank with dished ends. The tank is buried horizontally with a 20-in. opening centered at the top of the tank. A 30-in. corrugated man way centered over the 20-in. opening extends approximately 33 ft to the ground surface.

Before silo recovery is initiated, a submersible pump and level monitoring system is provided to control level in the sump. The level monitoring system is designed to monitor both level of liquid in the tank and the rate of level change in the tank. If the level set points are exceeded, the level monitoring system automatically annunciates alarms, terminates the operation of the TTA sluicing water supply pumps in the TTA, and initiates the operation of the sump pump. The sump pump is capable of pumping liquids to the Transfer Storage Tanks at the operator's discretion. The sump pump's operation automatically terminates on low level in the decant sump.

3.1.8 Long Reach Manipulator Arms

Long reach manipulator arms consist of lightweight mechanical linkages with various detachable heads. The detachable heads could be a hook, scrapper, gripper, or other mechanical assembly. These devices are used as necessary to clear away debris from the pump inlet screen plate.

3.2 DECANT SUMP WATER MANAGEMENT DURING SWRS

The Decant Sump Tank is located underground and just west of and between the silos. Underground drains beneath the silos and underground in the vicinity of the silos drain to the decant sump; therefore, during SWRS activities, the decant sump is monitored to ensure that the SWRS activities do not result in a significant increase in the volume of drainage observed in the decant sump.

Prior to the initiation of SWRS activities, existing liquids are pumped out of the Decant Sump Tank and a control system is installed in the decant sump. The level control system consists of level instrumentation and a submergible sump pump. The level instrumentation and the pump are lowered into the Decant Sump Tank through the Decant Sump Tank's 20-in. opening. The pump and level instrumentation remain in the sump throughout SWRS operations. The level instrumentation continuously monitors the liquid level in the decant sump. The level system also continuously monitors the rate of change in sump's liquid level. If the level rises in the tank above a set point during SWRS operations (a liquid level of 5 ft, which equates to approximately 50 percent of capacity), an alarm is initiated and the sump pump automatically begins to transfer liquid from the sump to the silos (Operations is responsible for determining which silo receives the liquid). The level instrumentation system also monitors the rate of level in the decant sump. If an abnormal rate of rise (greater than 7 in./hour) is observed during SWRS operations, the flow of sluicing water from the TTA to the silos will be terminated and the decant sump pump will automatically transfer liquids to the silos. The capacity of the sump pump (40 gpm) is large enough to ensure that overfilling of the Decant Sump Tank is prevented. The silo slurry transfer pumps will then transfer the liquid and any solids suspended by operation of the sump pump to the TTA.

3.3 TRANSFER STORAGE TANK AREA SYSTEM

The purpose of the TTA System is to stage residues received from Silos 1 and 2 for transfer to the Silos 1 and 2 Remediation facility which is to be located immediately east of the TTA. The TTA consists of a building that houses four 750,000-gal storage tanks, piping, a valve network for receiving and transferring slurried material, and auxiliary equipment.

Primary TTA System includes:

- Transfer Storage Tank 001A
- Transfer Storage Tank 001A Slurry/Decant Module

- Transfer Storage Tank 001A Sluicer Modules 1 and 2
- TTA Tank No. 001A CCTV Video Camera and Light
- Transfer Storage Tank 001B
- Transfer Storage Tank 001B Slurry/Decant Module
- Transfer Storage Tank Sluicer Modules 1 and 2
- TTA Tank No. 001B CCTV Video Camera and Light
- Transfer Storage Tank 002A
- Transfer Storage Tank 002A Slurry/Decant Module
- Transfer Storage Tank 002A Sluicer Modules 1 and 2
- TTA Tank No. 002A CCTV Video Camera and Light
- Transfer Storage Tank 002B
- Transfer Storage Tank 002B Slurry/Decant Module
- Transfer Storage Tank 002B Sluicer Modules 1 and 2
- Transfer Storage Tank No. 002B CCTV Video Camera and Light
- Equipment Deck
- Transfer Storage Tank Transfer Piping and Diverter Valves
- TTA Containment Area A
- TTA Containment Area B
- Transfer Storage Tank Leak Detection Sumps
- Make-up Water Storage Tanks
- Make-up Water Transfer Pumps
- High-Pressure Pump
- Long Reach Manipulator Arms

The TTA System is used in support of two different retrieval operations: SWRS and TWRS. The design description and functions of the TTA in support of each operation is provided in the following sections.

Four Transfer Storage Tanks are provided for storing wastes from Silos 1 and 2. The combined inventory of K-65 material and BentoGrout™ from Silos 1 and 2 is received, stored, and divided among the four Transfer Storage Tanks.

3.3.1 Transfer Storage Tanks

The carbon steel transfer storage tanks each have a capacity of 750,000 gal and are constructed in accordance with API 650. The design life of these tanks is 20 years. The tank volume allows for a maximum settled storage level of 90 percent of total capacity, although the tanks are designed for filling to their maximum capacity. The tanks are 66 ft in diameter, have a straight side dimension of 30 ft, and are provided with 1/4-in. corrosion allowance and an internal Plasite corrosion coating. The tank roofs are dome-shaped and are supported by rafters to minimize the overall height to 33 ft, 6 in. (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 operation.

The four 750,000-gal storage tanks are connected at their overflow nozzles by a 6-in.-diameter pipe. This overflow arrangement together with the use of level measurement devices in each tank minimizes the potential of exceeding the capacity of any one tank. All four tanks are ventilated to the RCS which is operated to maintain pressure in the tank headspaces between −2.0 and +0.5 in W.C. Pressure and vacuum relief devices provide additional (back up) pressure and vacuum relief.

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-in.-diameter nozzle located in the center for the Slurry/Decant Pump
- Two 20-in.-diameter nozzles located 180° apart for the Sluicer Modules
- One 20-in.-diameter nozzle for the RCS inlet
- Six 12-in.-diameter nozzles for the level switch, pressure differential transmitter, camera, and light, and three are spares
- Three 6-in.-diameter nozzles for level, slurry inlet, and RCS outlet

- One 12-in.-diameter nozzle for relief/vent
- One 6-in.-diameter nozzles overflow, located in the shell

Tank corrosion considerations include adding 1/4-in. additional thickness above that required for stress to the steel tanks, coating the interior surface with a Plasite protective coating (with a 30 mils dry film thickness), and painting the tank exterior steel surfaces. The decision to use and the choice of interior coating is based on the K-65 corrosion test results over a 20 year design life. The tanks are housed completely within a concrete and steel enclosure. The tanks are grounded to the TTA grounding grid. The grounding grid maintains building steel, including reinforcing steel, and components at the same electrical potential.

3.3.2 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 ft long, 152 ft wide, and approximately 40 ft tall with concrete walls for radiation shielding. Sealing the concrete floor and the walls to a level 8 ft above the floor provides secondary containment. This containment is equivalent to 100 percent of the volume that liquid from one 750,000-gal tank would occupy.

The floor is sloped to a centrally located sump to facilitate detecting leaks and removing spills. A tank foundation sump under each tank collects any leakage that may occur through or around the tank bottoms. The four-tank foundation sumps gravity-drain to the main enclosure sump through 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 back to the transfer storage tanks. Each tank has an exposed bottom sump drain line that empties into the central sump trench, thus allowing the operator to identify which tank is leaking by the camera system that can view all four sump lines.

If leaks are observed, the sump pump is used to transfer liquids from the sump to a non-leaking TTA tank. The TTA tank and piping system also allow liquid transfer from any of the four tanks to any other of the four tanks. This provision allows the contents of a leaking tank to be transferred to the remaining three tanks if a leak were to be observed.

3.3.3 Equipment Deck

The equipment deck covers the storage tanks. A steel column and beam system designed to carry floor and equipment loads supports the equipment deck. The support steel is primed and painted. The floor is concrete over steel. The equipment deck provides some level of radiation shielding from the stored residues.

A loading platform located on the southern side of the TTA is provided. The loading platform is fitted with a monorail type hoist for use when tools and equipment parts are to be taken in, or removed from, the TTA. Access to the equipment deck is provided through a 16-ft-wide, 24-ft-high roll-up door. Two staircases provide access and egress to/from the equipment deck. One staircase is located on the northern end of the eastern side of the TTA, and the other is located adjacent to the loading platform on the southern side of the TTA.

3.3.4 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 are directed to the storm drainage system. The deck enclosure is insulated and provided with heaters to maintain a target temperature of 55°F during cold months. Louvers and vents provide natural ventilation.

Personnel typically occupy the equipment deck area only when lines have been flushed and the transfer systems have been shut down for maintenance. The deck enclosure is also provided with doors, lights, gutters, and downspouts. A compressed air and domestic water header is routed around the perimeter of the enclosure with several drops provided to support maintenance activities.

3.3.5 TTA Transfer Piping

Sluice and slurry transfer piping is double-walled, except within the diverter valve containment areas and modules. Outdoor pipelines are insulated and heat traced. The pipeline is also provided with automated systems to detect leaks, monitor pipeline pressures, and measure slurry density.

Two containment areas are located on the TTA Equipment Deck. Within these areas, piping is single walled and enables use of flanged joints for valves and equipment. The flanges within these areas are fitted with flange guards to prevent spray from leaking joints. These areas are provided with sloped bottoms, sumps equipped with level instrumentation, and sump pumps. The sump pumps discharge collected liquids to the Transfer Storage Tanks.

3.3.6 TTA Containment Area A

Containment Area A is located on the northern side of the TTA Equipment Deck. Diverter valves are located in Containment Area A. This area is provided with a sloped bottom, level instrumentation, and a sump pump. The sump pump is designed to discharge collected liquids to the Transfer Storage Tanks.

3.3.7 Transfer Storage Tank Area Containment Area B

Containment Area B is located centrally on the TTA Equipment Deck. This area provides access to the Tank Vault sump. This area is provided with a sloped bottom, level instrumentation, and a sump pump. The sump pump is designed to discharge collected liquids to the Transfer Storage Tanks.

3.3.8 Make-Up Water Tanks

One 10,000-gal and two 7,500-gal storage tanks (Tank 51-001, Tank 51-002, and Tank 51-003, respectively) provide domestic water storage. The tanks are normally used together, acting as a single water source, but may be isolated in case one tank needs to be taken out of service for maintenance or other reasons. The three tanks are installed so that the top of the tanks are at the same elevation. This allows the common discharge header to equalize the tank level. Combined these three tanks have sufficient capacity to supply the silo sluicers backup water at full flow for approximately 1 hour. The tanks are equipped with level instruments to control the potable fill water valve based on tank level.

The tanks are constructed in accordance with API 650. They have flat bottoms supported on a concrete foundation. Corrosion considerations include painting external tank steel surfaces and providing a corrosion allowance of 1/16 in. Additionally, the interior of these tanks will have a 30-mil dry film thickness Plasite coating.

3.3.9 Make-Up Water Pumps

Make-up water is transferred from the make-up water tanks by one of two centrifugal pumps located adjacent to Make-up Water Tank. The make-up water pumps transfer domestic water to the Remediation Facility RCS, the SWRS and TWRS process water to Silos 1 and 2, and the Transfer Storage Tanks. The programmable logic controller (PLC) automatically stops the pumps on low tank level.

3.3.10 Slurry/Decant Pumps

The Slurry/Decant Pumps, used to supply supernatant for silo sluicing and also to retrieve slurry from the transfer storage tanks, are deployed from their modules located over the center nozzle of each Transfer Storage Tank. Slack hose and cable are suspended in the tank with enough length to allow the pump to reach the bottom of the tank. As the tank is filled and the pump is raised, lengths of cable and hose are disconnected and retracted from the riser.

There are four independent Slurry/Decant Pump systems. One Slurry/Decant Pump will be dedicated to each transfer storage tank. This arrangement allows critical operational and water management flexibility.

A sensor is mounted near the pump intake to determine liquid level. If the liquid level is low, the sensor detects the low level and turns the pump off.

The Slurry/Decant Pump is a centrifugal-style, submersible sump pump. The pump normally delivers 300 gpm to the silo sluicing nozzles at 200 psi. The impeller and wear components are made of abrasion-resistant material. An agitator and high-pressure spray ring are included ahead of the pump suction. The agitator and spray ring keep the solids in a slurry form as well as help the pump "dig" into the K-65 and BentoGrout™ material. The spray ring shuts off during sluicing supply operations. Additionally, a strainer screen plate is mounted at the pump suction to protect the pump from damaging debris entering it. The

Slurry/Decant Pump drive motor is a super severe duty (Service Factor = 1.35), requiring 480 VAC, 60 Hz, three-phase power. The pump is provided with variable speed control to allow for flow control.

3.3.11 Slurry/Decant Pump Enclosure

The Slurry/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 a hoisting mechanism 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 motor-operated multi-port valves and piping/hoses to direct flows. 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 are 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 enclosure atmosphere control.

3.3.12 *Transfer Storage Tank Sluicers*

Each TTA tank has two sluicers installed in it. Each sluicer is contained in a steel module, which is mounted on the equipment deck. To maintain TTA flow balance during bulk retrieval, the total sluicing flow rate is fixed whether operating one or both sluicing nozzles. Each of the nozzles are remotely articulated from the Control Room in an automatic or manual mode to allow either vertical channel cutting or horizontal sweeping as necessary. Each sluicer has a 340° horizontal rotation and 105° vertical rotation capability.

As the level of the waste decreases, the TTA sluicers also have the ability to be 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 mast hoist in each of the sluicer enclosures accomplishes fine adjustment of either of the main nozzle's elevation. The mast hoist is normally operated from the Control Room but may also be operated locally when adding or removing sections.

The sluicing deployment system for the TTA sluicers is housed in a Sluicer Enclosure. The enclosure serves as secondary containment and drains to the TTA tank. Currently the enclosure measures approximately 6 ft by 10 ft by 20 ft high. The enclosure weighs approximately 15,000 lb and has several gloveport panels, an 11-ft by 3-ft access door, and a 2-ft by 2-ft pass-through. The weight of the sluicing system is supported off the TTA equipment deck. The sluicing system is connected to the TTA tank by a flexible coupling or bellows that allows small vertical or horizontal movement without inducing stresses to the TTA tank.

The TTA sluicers are removed from the TTA tank while being decontaminated by a high-pressure spray ring passed through a radiation-monitoring ring. Manual washing with a spray wand occurs through the glove ports as the equipment is removed to ensure that the equipment is properly cleaned.

3.3.13 Polymer System

A polymer additive system mounted on a skid is provided as a contingency plan to aide settling in the TTA tanks. Rapid solids settling in the TTA tanks ensure that an adequate supply of sluicing water is available. The polymer addition system is provided as a contingency and may not be used if the waste materials settle quickly without polymer addition. Provisions are made to add polymer directly to the slurry lines connecting the silos to the TTA and to the decant lines connecting the four TTA tanks.

3.3.14 Long Reach Manipulator Tools

Long reach manipulator tools consist of lightweight mechanical linkages with various detachable heads. The detachable heads could be a hook, scrapper, gripper, or other mechanical assembly. These devices are manually used as necessary to clear away debris from the pump inlet screen plate.

3.4 TRANSFER STORAGE TANK WASTE RETRIEVAL SYSTEM

The TWRS is designed to access, mobilize, and transfer waste residue stored in the TTA System. The function of the TWRS is to provide the capability to retrieve and transfer the entire inventory of waste from the Transfer Storage Tanks to the Remediation Facility for final treatment process. Each TTA tank is provided with two sluicing systems and a slurry pump system. The equipment on each TTA tank and on the silo bridges is of the same design and fully interchangeable. During TWRS activities, the Slurry/Decant Pump system is operated as a slurry transfer system rather than as a sluicing water supply system. To accomplish slurry transport the variable speed pump controls are used to adjust the discharge of the pump to 350 gpm at 150 psi.

Equipment is provided for the transfer of stored residues from any one of the four TTA tanks to any other TTA tank. Motor-operated multi-way diverter valves with flange connections will be provided for connecting slurry and sluice water piping. Sluice water for TWRS operations are supplied from the Silos 1 and 2 Remediation Facility. The TTA System provides piping and valves between the new Remediation Facility interface point and each of the four TTA tanks. The two sluicer modules and the Slurry/Decant Pump module are connected to each storage tank so that any TTA tank can be emptied, even as it is being filled. 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 the site's yearly limit. Operating controls for the TWRS are included in the Control Room. These controls allow the shutdown or start-up of TWRS equipment. Local controls for the TWRS subsystems are provided on the TTA Equipment Deck.

Automated functions of the TWRS are controlled by a PLC. These controllers process system events that require alarming. Local evacuation alarms are staged on the TTA Equipment Deck. The alarms also may be activated from the Control Room. Alarms are recorded and annunciated locally and in the Control Room.

3.5 WASTE RETRIEVAL OPERATING MODES

The AWR project encompasses multiple modes of operation as the K-65 material is transferred from the silos to the TTA and ultimately to the Silos 1 and 2 Remediation Facility.

For the AWR Project, the silos, Transfer Storage Tank System, and Remediation Facility are designed to operate in three possible general configurations – SWRS, TWRS, and Remediation Facility Slurry Recycle. The valve configuration design creates this operating flexibility. Based on the possible tank and valve configurations, four operating scenarios are considered likely to occur. One scenario occurs when slurry is retrieved from one of the silos. Another likely scenario is to retrieve slurry from one of the Transfer Storage Tanks. A third scenario is to operate SWRS and TWRS concurrently. The fourth possible scenario is to concurrently retrieve slurry from any one of the Transfer Storage Tanks and recycle slurry from the Remediation Facility to a different Transfer Storage Tank. These are not the only possible scenarios, they are considered to be most likely.

3.5.1 SWRS Mode

In this mode, supernatant (sluice water) is pumped from one Transfer Storage Tank to the sluice nozzle(s) in one silo, while slurry retrieved from that silo is pumped to a different Transfer Storage Tank. The concept (see Figure 3.5.1) depicted is to use supernatant from one Transfer Storage Tank to retrieve slurry from one of the silos. The slurry will be pumped into a different Transfer Storage Tank and allowed to settle. In the SWRS mode, supernatant, if available, potentially may be drawn from any of three Transfer Storage Tanks and supplied to either silo. Depending on level in a particular Transfer Storage Tank, retrieved slurry could be pumped to any Transfer Storage Tank except the tank from which supernatant is being drawn. In this operating configuration, one silo and two Transfer Storage Tanks are operating, and the other silo and two Transfer Storage Tanks are idle.

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Figure 3.5.1

Silo Waste Retrieval System (SWRS) Operating Mode

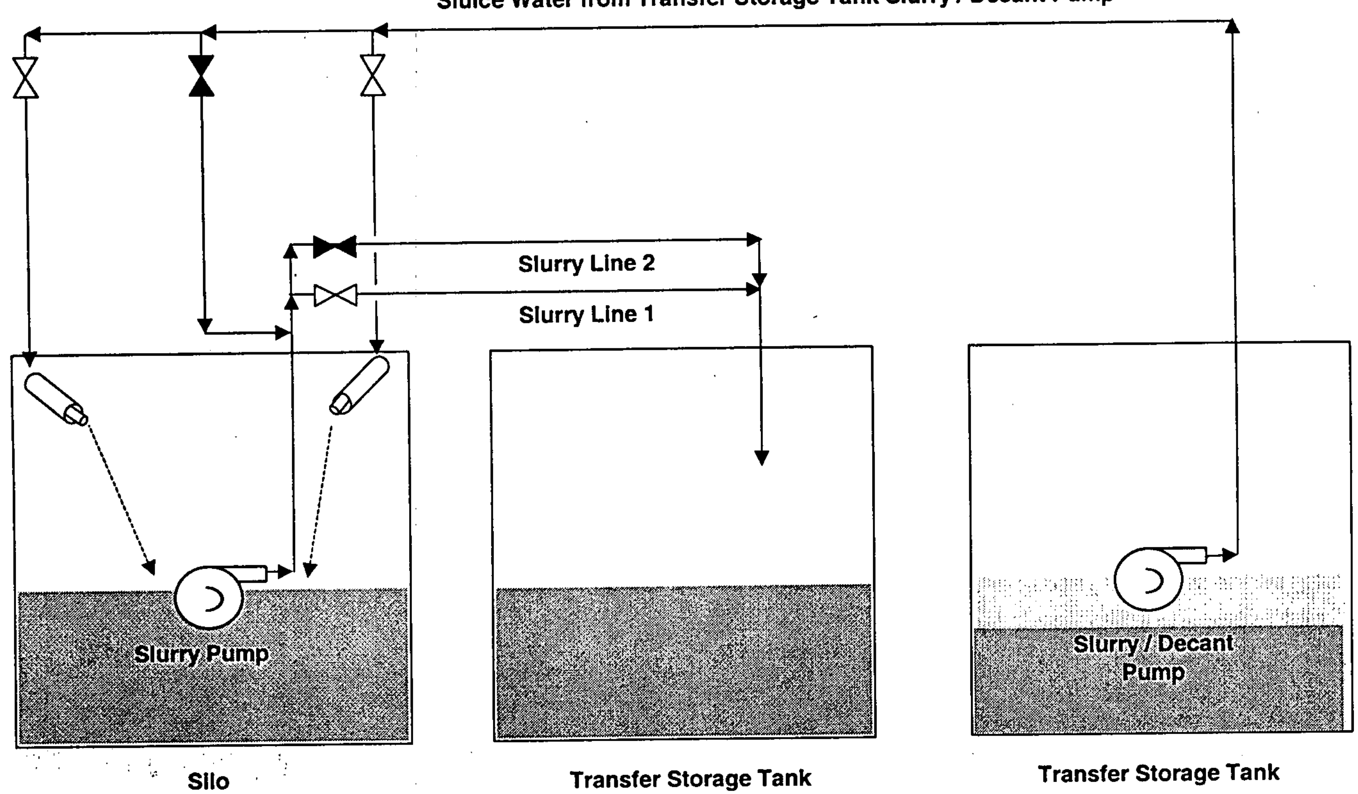

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Figure 3.5.2

Transfer Storage Tank Waste Retrieval System (TWRS) Operating Mode

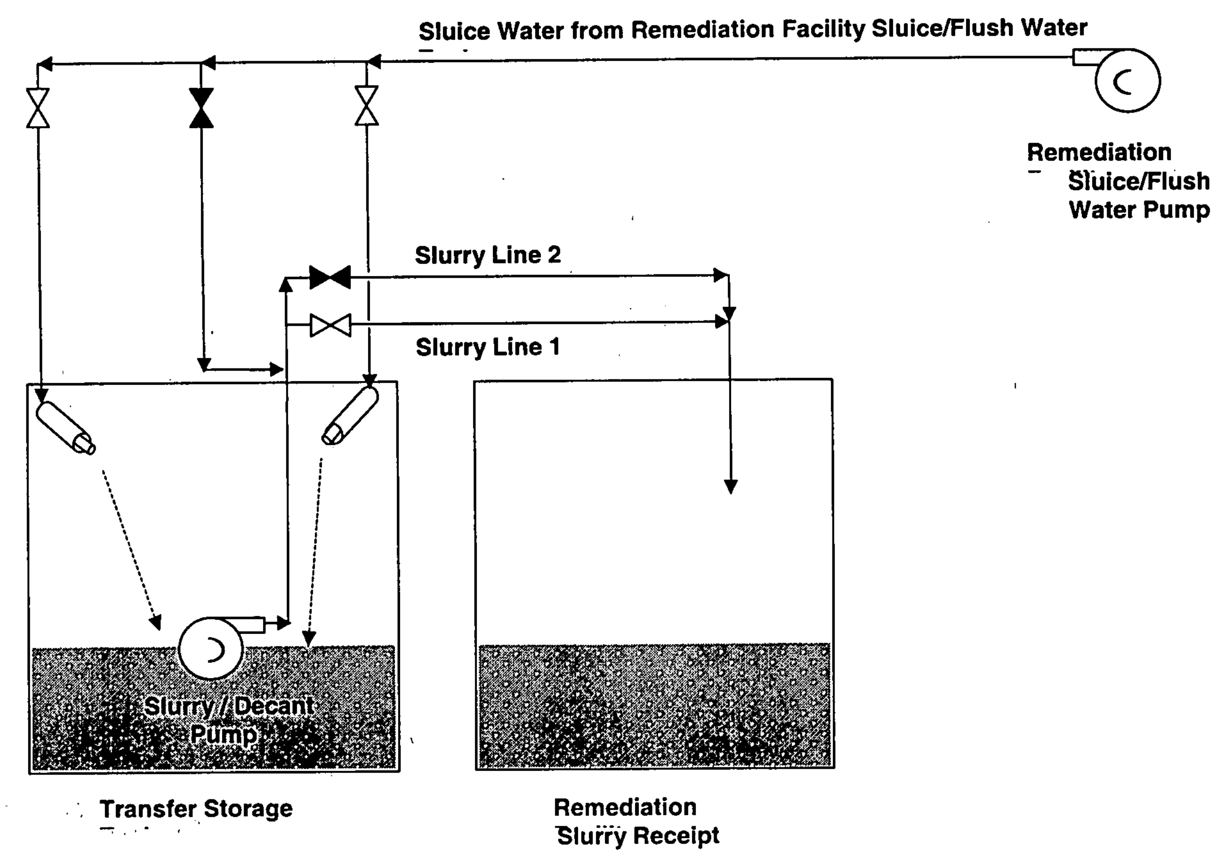

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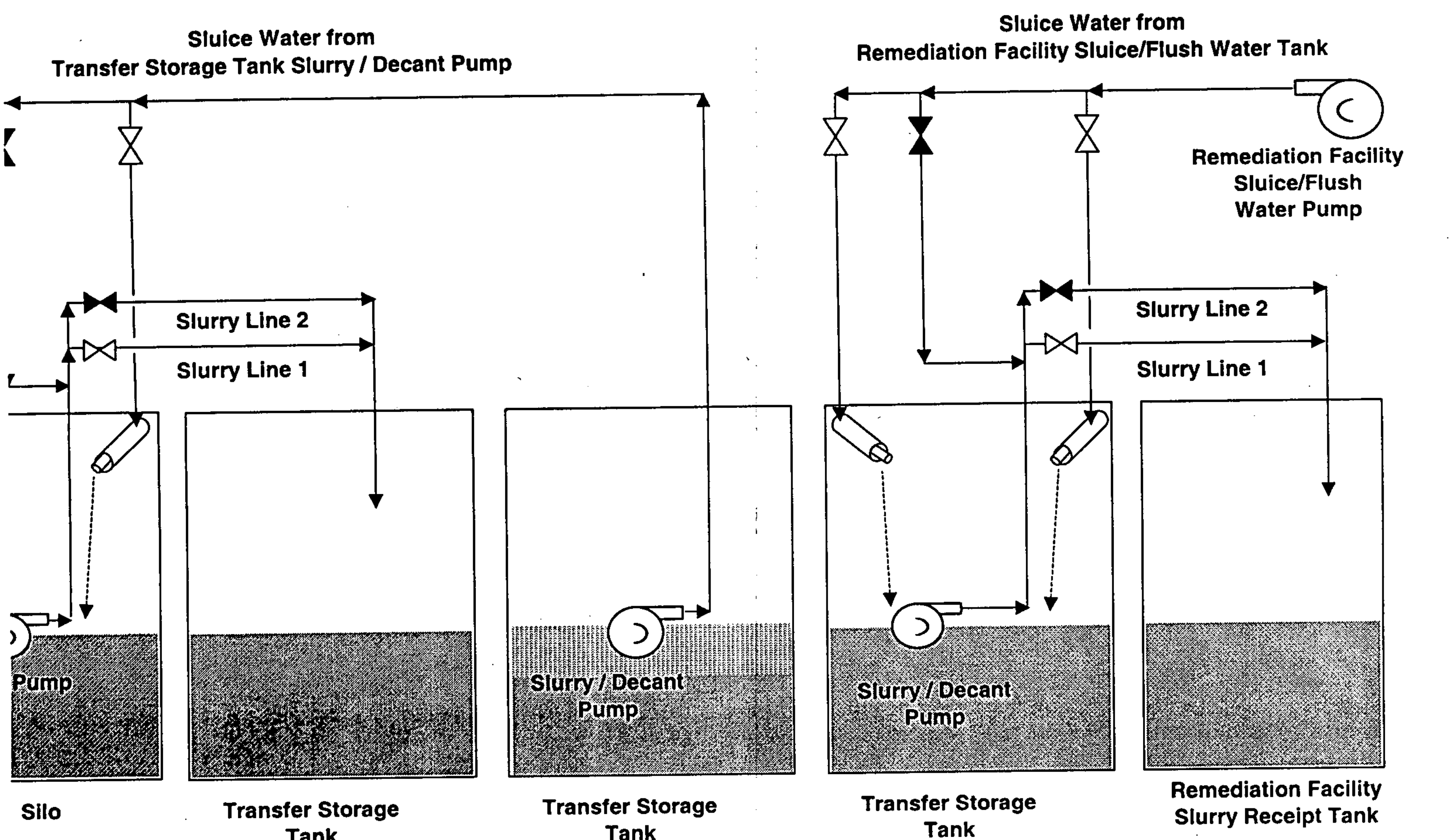
Figure 3.5.3
Concurrent Silo Waste Retrieval System (SWRS) and
Transfer Storage Tank Waste Retrieval System (TWRS) Modes



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When slurry transfer is complete, sluice water or process water will be used to flush the slurry lines between the silo and Transfer Storage Tank.

3.5.2 TWRS Operating Mode

In this mode, supernatant (sluice water) is pumped from the Remediation Facility to the sluice nozzle(s) in one Transfer Storage Tank, and slurry retrieved from that tank is pumped to the Remediation Facility. The concept (see Figure 3.5.2) depicted is to use supernatant from the Remediation Facility to retrieve slurry from any one of the four Transfer Storage Tanks. In this configuration, one Transfer Storage Tank is operating and both silos and three Transfer Storage Tanks are idle.

When slurry transfer is complete, sluice water or process water will be used to flush the slurry lines between the silo and Transfer Storage Tank and the Remediation Facility.

3.5.3 Concurrent SWRS and TWRS Operating Modes

In this mode, two operations are occurring concurrently (see Figure 3.5.3). Supernatant (sluice water) is pumped from the Transfer Storage Tank to the sluice nozzle(s) in one silo, while slurry retrieved from that silo is pumped to a different Transfer Storage Tank. Simultaneously, supernatant (sluice water) is pumped from the Remediation Facility to the sluice nozzle(s) in a third Transfer Storage Tank, and slurry retrieved from that tank is pumped to the Remediation Facility. This operation leaves one Transfer Storage Tank to operate in the decant mode, in which slurry water and slurry solids separate to generate supernatant on top of the slurry material.

When slurry transfer is complete, sluice water or process water will be used to flush the slurry lines between the silo and Transfer Storage Tank and the Remediation Facility.

3.6 RADON CONTROL SYSTEM

The RCS receives off-gases from the following sources: the silos, SWRS, all residue transfer systems, the TTA System, and the future Silos 1 and 2 Remediation Facility. The RCS removes radon from gas streams, reduces radon releases to the atmosphere, monitors all releases to the atmosphere for radon and other radiological material, and mitigates system upsets. The RCS is constructed in two phases:

- RCS Phase 1 reduces and controls radon concentrations in the silos' headspace prior to construction in the silos area and prior to the initiation of waste retrieval.
- RCS Phase 2 reduces and controls radon concentrations in the associated Silos Project Facilities (e.g., TTA, Silos 1 and 2 Remediation Facility).

3.6.1 RCS – Requirements

The RCS is designed according to the following requirements and criteria.

- Prevent over/under pressurization of the silos and transfer tanks beyond +0.5 in. W.C. and −2.0 in. W.C. beyond their design.
- Maintain radiation fields on the surface of the silos' domes below 10 mrem/hr during construction periods of Phase 1 and during all of Phase 2.
- Provide sufficient shielding and exclusion area fence to maintain the area outside the RCS facility as a Radiation Access Zone 1 (less than 0.4 mrem/hr) during all phases.
- Ensure that there are no uncontrolled releases of radon to the atmosphere.
- Provide local evacuation alarms.
- Provide both local and remote monitoring and control to verify RCS process control.
- Provide a design life of 20 years.
- Provide isokinetic sampling, monitoring, and recording on all stack exhaust streams to atmosphere in accordance with 40 *Code of Federal Regulations* (CFR) Part 61, Subpart H. Provide remote alarm capability to indicate buildup of radioactive particulate. Provide continuous monitoring of the stack exhaust radon concentration.
- Maintain radon emissions from the exhaust stack below the level resulting in an annual average concentration of 0.5pCi/L above background at the FEMP fence line.
- Provide safe shutdown, secure stand-by, and restart capability.

3.6.2 RCS–Process Description

The RCS includes two separate treatment equipment configurations or phases. Phase 1 continuously reduces and controls the concentration of radon in the silos' headspace until the SWRS is operational. Phase 1 recycles air from the silo headspaces through a radon treatment system to lower headspace radon concentration. After the radon count is lowered in the headspace and waste transfer is ready to begin, additional equipment will be added to the Phase 1 equipment for conversion to the Phase 2 system.

Phase 2 provides control of radon during waste removal and transport of residues and residue staging in the TTA. Phase 3 operation supports transfer from the TTA and operation of the Silos 1 and 2 Remediation Facility. The fans and other equipment have been designed to support concurrent operation of bulk waste retrieval and the Silos 1 and 2 Remediation Facility with a total flow of 2,000 cfm. Additional carbon beds may be added to support operation at 2,000 cfm, if identified as necessary based upon data collected during Phase 1 operation. The Phase 2 and 3 Systems are designed to provide a minimum of 25 ft per minute minimum capture velocity during events in which contaminated areas are opened to the atmosphere.

Phase 1 is a recirculating system operating four carbon beds in a parallel configuration. Each carbon bed contains 40,000 lb of carbon. Headspace air is pulled from the silos at 500 cfm per silo and combined into one air stream. The 1,000 cfm combined air stream passes first through a dehumidification and chilling system to remove excess moisture and chill the air to approximately 45°F. The chilled air passes through a desiccant drying system, which removes the remaining moisture and heats the air up to about 80°F. The air stream then passes through another cooler to cool it back down to 40°F prior to entering the carbon beds. The air stream (conditioned to 40°F and 15 percent relative humidity) then passes through the carbon beds for radon removal. The four carbon beds are connected in parallel, each receiving a generated flow of 2,500 cfm. The headspace air is monitored for radon both upstream and downstream of the carbon beds to determine the removal efficiency. Upon exiting the carbon beds the air stream passes through the recirculation fan before being returned to the silo headspaces.

Phase 2 is designed as a once-through treatment system using the same process equipment as that described for Phase 1. During Phase 2 the recirculation fans are utilized to produce an induced draft ventilation stream through the silos, TTA tanks condensate tanks, and the various equipment modules. During normal Phase 2 operations the treated air stream will pass through the carbon beds, HEPA filter train and exhaust through a monitored stack to the atmosphere. If abnormal radiological conditions are detected at the stack, the RCS's control system automatically alarms and switches from the once through mode of operation to the recycle mode of operation.

During Phase 3 the RCS operates in the same manner as Phase 2 except Silos 1 and 2 Remediation Facility ventilation is added to the RCS treatment process. The addition of Silos 1 and 2 Remediation Facility ventilation increases the flow; therefore the RCS has been designed to handle this increased capacity to 2,000 scfm.

Additional carbon beds may be added during Phase 2 to enhance the system's radon removal capabilities. The need for additional carbon beds will be evaluated during Phase 1 operation.

The 500 cfm vent rate from each silo should maintain the silo headspaces at less than 500,000 pCi/L based on pre-bentonite rates of radon emanation into the silo headspaces. The 160,000 lb of carbon provided is designed to keep radon emissions to atmosphere to less than 0.2 Ci/day per silo.

3.6.3 Air Drying and Cooling

Previous radon control studies have indicated that the efficiency of radon adsorption onto carbon is enhanced when moisture and temperature are reduced. This air conditioning system is common to all Phases of the RCS operation. The air-drying and -cooling system is composed of three components: condenser, air dryer, and cooler. The air pulled from the silos is first passed through a water-cooled condenser. The air temperature is dropped to 40°F saturated air based on inlet conditions 95°F air at 100 percent relative humidity. This step removes the readily condensable moisture and helps to minimize the required capacity of the air dryers. The air dryers use desiccant to remove the remaining moisture from the air stream. Using desiccant to dry the air raises the air stream temperature above the optimum temperature for removing radon with carbon beds. Therefore, prior to entering the carbon beds, the air stream is passed through a cooler. The conditioned air enters the carbon beds at 40°F and 15 percent relative humidity.

3.6.4 Carbon Beds

Radon is a radioactive inert gas with a short half-life (3.82 days). Because radon is an inert gas, it does not react with other chemicals. Radon has an affinity for activated carbon, which can be used to trap radon and allow it to decay to its daughter products. For the carbon beds to be effective, the air must be cool and dry as it enters. Phases 1 and 2 use four carbon beds operated in parallel. If required, Phase 3 may add additional beds to the system. Each carbon bed includes a 15-ft-long by 10-ft-wide by 10-ft-high steel shell containing 40,000 lb of activated carbon.

Since the RCS design includes redundant desiccant dryers, as well as demisters upstream of the beds to dry all air entering the carbon beds, buildup of excessive moisture, and the need to dry a bed is not expected to occur frequently. Radon monitors and moisture monitors will be used to monitor the condition and effectiveness of each bed. Based on the data from these monitors, the need to regenerate a bed will be identified and initiated. Regeneration will be accomplished by isolating the bed requiring drying and recycling dried air from the desiccant drying system through the bed until it has been sufficiently dried. The RCS provides sufficient excess carbon adsorption capacity maintain specified emission limits while the impacted carbon bed is being dried.

3.6.5 HEPA Filter Train

All gasses discharged from the RCS pass through a HEPA filter system downstream from the carbon units to remove particulate material prior to exhausting through the stack. The HEPA filters are used to trap fine particulates and typically have an efficiency rating of 99.97 percent for 0.3-micron particles.

The HEPA filters are housed in a steel frame. They are single stage HEPA filters with 45 percent pre-filters. The HEPA housings are designed for bag-in/bag-out filter changes. and are equipped with dioctyl phthalate testing ports, static pressure taps, and lifting lugs.

3.6.6 Stack and Monitor

The exhaust stack is located adjacent to the west of the RCS building. The stack is constructed of carbon steel and is approximately 150 ft tall. The stack is equipped with both continuous radon and isokinetic particulate monitoring. Isokinetic monitoring will include continuous flow recording. Scaffolding and equipment platforms to support the monitoring in accordance with 40 CFR Part 60, Appendix A, Method 1, are included in the design.

3.6.7 RCS – Facility Description

The RCS facility houses RCS process equipment and the carbon beds. This includes the desiccant drying system, condensate holdup tanks, filters, and fans. The carbon beds are located in precast concrete vaults adjacent to the building. Vaults are provided with shield walls. The concrete vaults are designed in a modular fashion so that additional carbon beds can be added with very little down time. The first floor of the RCS building houses the roughing filters, chilling coils, desiccant dryers, and condensate tanks. The first floor area is provided with 2-ft-thick walls for shielding. The RCS building is ventilated and heated to maintain appropriate operating temperatures and be as low as reasonably achievable compliant. The RCS building ventilation system maintains the RCS building at a negative pressure relative to the atmosphere and ensures that airflow through the building is directed from less contaminated areas to more contaminated areas. Floors are coated with a sealant to facilitate decontamination and provide secondary containment for the condensate hold-up tanks. The carbon bed vaults are provided with an independent ventilation system designed to maintain the carbon beds at 60°F or less. Air passing through the RCS building is discharged from the monitored RCS stack.

4.0 AWR SUPPORT SYSTEMS

4.1 CONTROL SYSTEMS

The AWR Project consists of several separate phases and activities that require different process controls. The AWR RCS 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 require controls to start, stop, and periodically control operation. To accomplish these multiple functions and activities the AWR Process Control Philosophy is to use two independent control systems. These systems are (1) the Balance of Plant (BOP) Control System and (2) the RCS.

The two independent control systems are integrated through a fiber optic cable link and the Siemens 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. The RCS system is provided with an independent control system but is provided a link to the BOP Control System.

The BOP Control System does not provide control input signals to the RCS control systems, but it does receive and log status and alarm signals from the RCS Control. In the case of an alarm or status signal requiring action from the RCS control system, the operator will need to operate the appropriate human-machine interface (HMI) and take the necessary action.

4.1.1 System Concept

The AWR Project distributed control systems (DCS) will be a PLC-based system with distributive input/output (I/O) data collection and control nodes. The PLCs and redundant operator HMI stations will be located in the Control Room. The data collection and control nodes are expected to be located at the Silo Bridge, high-pressure pumps, and the TTA building. The distributive I/O data collection and control nodes will be connected to the PLCs by a fiber optic network. The individual equipment items located at the I/O nodes will be connected to the nearest I/O node with field wiring.

4.1.2 Distributed Control System

The AWR Project DCS will be an integrated system that will allow both local control at the equipment site and remote control at the central control room station, located in the Control Room. The AWR Project DCS supports operations during SWRS and TWRS waste removal operations, as well as TTA System monitoring.