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DOE/RL-2010-63-ADD-3B
Revision 0

Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Removal of K Basins Sludge from the River Corridor to the Central Plateau; and Removal of Knock Out Pot Contents from the K Basins

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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APPROVED
By Shauna Adams at 11:32 am, Jun 28, 2013

Release Approval Date

Printed in the United States of America

Signature Sheet

Signature sheet for the *Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Removal of K Basins Sludge from the River Corridor to the Central Plateau; and Removal of Knock Out Pot Contents from the K Basins* (DOE/RL-2010-63 ADDENDUM 3B) at the U.S. Department of Energy's Hanford Site. This action is conducted by the U.S. Department of Energy with the approval of the U.S. Environmental Protection Agency.

Thomas K. Teynor
Acting Federal Project Director RCCP
U.S. Department of Energy, Richland Operations Office

28 June 2013
Date

Signature Sheet

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Rod A. Lobos
Project Manager
Region 10
U.S. Environmental Protection Agency

7-1-2013
Date

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Terms

105-KW	105-K West
ALARA	as low as reasonably achievable
Annex	Modified 105-K West Basin Fuel Transfer System Annex
ARAR	applicable or relevant and appropriate requirements
ASME	American Society of Mechanical Engineers
EC	engineered container
ECRTS	Engineered Container Retrieval and Transfer System
HEPA	high-efficiency particulate air
HIH	hose-in-hose
IWTS	integrated water treatment system
IXM	ion exchange module
MASF	Maintenance and Storage Facility
NTU	nephelometric turbidity unit
RAO	remedial action objective
RD/RAWP	remedial design/remedial action work plan
ROD	record of decision
STS	sludge transport system
STSC	sludge transport and storage container

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1 Introduction

This addendum provides the 90 percent design report for the Engineered Container Retrieval and Transfer System (ECRTS), a quality assurance project plan for those field measurements associated with removing and transferring sludge to T Plant, and an air monitoring plan associated with removing sludge. The ECRTS will be used to retrieve the sludge currently in the 105-K West (105-KW) Basin and transfer the sludge to sludge transport and storage containers (STSCs) for transport to the Hanford Site's T Plant for temporary storage, pending future treatment and packaging for disposal at an approved national repository. This information is built upon the parent remedial design/remedial action work plan (RD/RAWP; DOE/RL-2010-63, *Remedial Design/Remedial Action Work Plan for the K Basins Interim Remedial Action: Removal of K Basins Sludge from the River Corridor to the Central Plateau; and Removal of Knock Out Pot Contents from the K Basins*). The RD/RAWP, ADDENDUM 3A, provided a 60 percent remedial design report for the ECRTS and 90 percent remedial design details of the 105-KW Basin Modified Fuel Transfer Annex (Annex). The Annex will house some of the equipment and processes to accommodate the transfer and hydraulic loading of sludge into STSCs. Additional equipment will be installed in the 105-KW Basin.

The purpose of the ECRTS is to retrieve and transfer the sludge from the 105-KW Basin into STSCs and transport the STSCs to T Plant. The ECRTS is comprised of five main processes:

- Receipt and preparation of empty STSCs
- Sludge retrieval and hydraulic transfer from engineered containers (ECs) to STSCs
- Sludge flocculation, settling, and filtration of decanted water
- STSCs and sludge transport system (STS) cask inerting and transport to T Plant
- Excess sludge retrieval from STSC if overfilled

The ECRTS process equipment will be housed in the 105-KW Basin and the Annex, 24.4 m (80 ft) north of the 105-KW Basin. The Annex will include a new structure and building systems built partially on the site where the previous Annex was located. The purpose of the Annex and its building systems is to provide emission control and sampling system as well as retention of wastewater from facility drains that would collect water from activation of the facility fire protection system.

The removal of the sludge from the 105-KW Basin implements the decisions, applicable or relevant and appropriate requirements (ARARs), and remedial action objectives (RAOs) established in the following documents:

- EPA/ROD/R10-99/059, *Interim Remedial Action Record of Decision for the 100-KR-2 Operable Unit K Basins, Hanford Site, Benton County, Washington*, commonly referred to as the K Basins Interim Action Record of Decision (ROD)
- *Amendment to the Record of Decision for the U.S. Department of Energy Hanford Site 100 K Area K Basins Interim Remedial Action* (EPA et al., 2005), commonly referred to as the K Basins Interim Action ROD amendment

The remedial design described in this addendum is specific to removing sludge from the 105-KW Basin using the ECRTS. While the design is based on the removal of sludge in the 105-KW ECs, this design or adaptations of it may also be used in the removal of filter media from both the ECRTS and 105-KW Basin water treatment systems as part of the facility deactivation as described in DOE/RL-2010-52, *Remedial Design and Remedial Action Work Plan for the K Basins Interim Remedial Action: 105-K West Basin Deactivation.*

Included in this addendum is a description of the ECRTS, process drains, process vents, the Annex stack sampling system, the quality assurance project plan for those field measurements associated with the removal and transfer of 105-KW Basin sludge to T Plant, and modifications made within the 105-KW Basin.

2 Background

K Basins sludge is stored in six ECs underwater in the 105-KW Basin. The sludge in the ECs is segregated based on its origin. Sludge in EC 210 and 220 is floor and pit sludge vacuumed from the 105-KW Basin. EC 230 sludge has been retrieved from the settler tanks that were part of the 105-KW Basin integrated water treatment system (IWTS) used to collect fine particulate generated during the cleaning of spent nuclear fuel. Sludge in ECs 240, 250, and 260 is floor and pit sludge retrieved from the 105-K East Basin and transferred to the 105-KW Basin for removal with the rest of the sludge.

Sampling and characterization of the sludge was performed based on a data quality objective report (HNF-36985, *Data Quality Objectives for Sampling and Analysis of K Basin Sludge*) and two quality assurance project plans/sampling and analysis plans (KBC-33786, *Quality Assurance Project Plan/Sampling and Analysis Plan Sludge in the KW Engineered Containers* and KBC-40467, *Quality Assurance Project Plan/Sampling and Analysis Plan for Containerized KW Settler Sludge*). Table 1 provides a high-level summary of the results from this sampling and characterization effort. More detailed sludge characterization information is documented in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Volume 2, Sludge*.

The sludge is classified as remote-handled transuranic polychlorinated biphenyl remediation waste. Sludge will ultimately be treated and packaged to meet the waste transportation and acceptance criteria for disposal at a national repository.

Table 1. Summary of ECRTS Feed Stream Characteristics

	EC 230 KW IWTS Settler Tank Sludge	**ECs 240, 250, 260 KE Basin Floor and Pit Sludge**	**EC 210 KW Basin Floor and Pit Sludge**	**EC 220 KW Basin Floor and Pit Sludge**	**Total**
Volume, m^3	3.5	18.4	4.2	1.0	27.1
Settled sludge density (g/cm^3; design basis)	2.0	1.5	1.25	1.47	-
Uranium Metal (g/cm^3; design basis)[a]	0.022	0.00027	0.0042	0.0121	-
Uranium Metal (g/cm^3; safety basis)[b]	0.144	0.00457	0.0593	0.0341	
Source Term Inventory of Key Isotopes (Curies) per EC					
Cesium-137	2,226	1,128	559	214	4,127
Strontium-90/ Yttrium-90	7,630	2,244	1,050	710	11,634
Plutonium-239	283	84	23	19	409
Plutonium-240	166	47	13	11	237
Americium-241	469	139	38	32	678

a. Design basis values were taken directly from the numerical average from the analyses of sludge samples. Systematic errors are not included; however, the values are based on a confidence level of 99% that the true mean is below the stated value.

b. Safety basis values were calculated such that there is a 95% confidence that 99% of the data is below the stated value.

3 Design and Processing Bases

3.1 ECRTS Design Basis

The design basis of the ECRTS consists of the following:

- RAOs and ARARs, and their implementation are described in Sections 2.2 and 2.4 of the RD/RAWP (DOE/RL-2010-63);
- Sludge characteristics derived from the completed sludge sampling and characterization campaigns as documented in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Volume 2, Sludge*;
- Functional design criteria and performance requirements described in HNF-40475, *Function Design Criteria Sludge Treatment Project Phase 1 – ECRTS*; and
- Industry codes and standards described in HNF-44226, *Code of Record Sludge Treatment Project.*

3.2 ECRTS Processing Basis

ECRTS processing will be considered complete once sludge has been removed from the 105-KW Basin in accordance with *End Point Criteria for the K Basins Interim Remedial Action* (HNF-20632).

4 ECRTS Design Description

A description of the ECRTS process for retrieving sludge from the ECs in the 105-KW Basin and filling the STSCs with that sludge is provided in the following sections. Figure 1 is a flow diagram of the ECRTS process showing the major components. The Annex will not normally be occupied during sludge transfer operations. Operations will be monitored and controlled remotely, with the interior of the Annex loading bay monitored by closed circuit television cameras.

An empty STSC located within the STS cask will be received from T Plant at the Annex. The STS cask and transport trailers are existing systems. The STS cask is designed to stay on the transport trailer. The transport trailer will be positioned in the Annex and aligned with the STS equipment. After the trailer has been aligned, the tractor will be decoupled from the trailer and removed from the Annex.

The transporter, STS cask, and STSC will then be prepared for loading. An initial (empty) weight of the STSC/STS cask on the trailer will be obtained. An overhead bridge crane will be used to remove the STS cask lid and place it on the transport trailer. The sludge transfer, decant and sand filter backwash hoses will be connected manually to the nozzles on the STSC. The process ventilation lines and purge line will be connected to the STSC, and the liquid level detector, high-level switch, slurry leak detector, supernate leak detector, and turbidity probe in the STSC will be connected to the ECRTS. The STSC will then be filled with treated water from the basin ion exchange module (IXM) and a weight measurement taken for process control. The IXM water will then be removed from the STSC to minimum pick-up suction level using the decant pump system. If settler tank sludge is to be loaded, the STSC with the annular design will be used. Ion exchange module water will be added to the inner vessel within the annular STSC and allowed to overflow into the STSC annulus as part of filling the STSC. The IXM water will then be removed from the STSC annulus using the decant pump system, leaving water in the inner vessel and a heel in the annulus. A weight measurement of the STSC/STS cask and trailer will be taken at this point to establish the heel tare weight for process control during sludge loading.

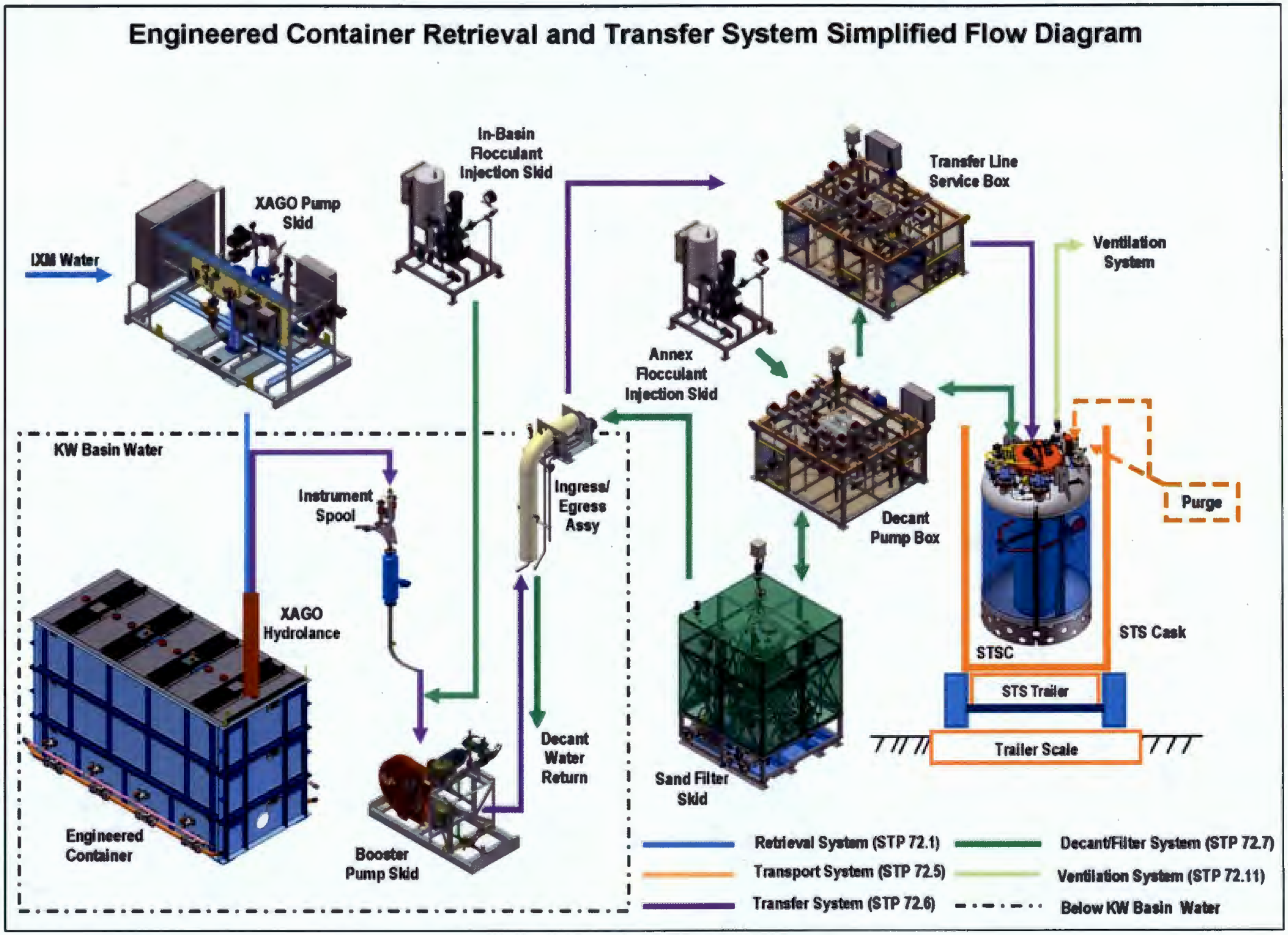

Figure 1. ECRTS Process Flow Diagram

A batch of sludge will be retrieved from one of the ECs and transferred into the staged STSC. Flocculant will be added to the sludge during the transfer to enhance settling of the suspended solids. Sludge will be allowed to settle within the STSC to concentrate the solids and clarify the supernate. Additional flocculant will be added to the supernate, if necessary. After the supernate has clarified during the settling period, it will be decanted and filtered to remove suspended sludge particles. The filtered supernate will be returned to the basin. Subsequent batches of sludge will be added to the STSC, settled, and excess supernate removed in the same manner as previously described until the prescribed quantity of sludge is collected into a STSC. After the final retrieval batch, the solids collected on the filtration unit will be backwashed directly into the STSC. Water will be added to the STSC to fill the container, leaving approximately 38 cm (15 in.) of headspace for gas accumulation during transport. The STSC will be purged with an inert gas (nitrogen), ports will be configured for transport, the STS cask lid will be installed, and the STS purged with an inert gas (nitrogen). Radiological surveys will then be performed and the STSC will be transported to T Plant for temporary storage.

If too much sludge is added to a STSC, a method will be provided to retrieve sludge from the STSC and return it to the source EC in the basin. The retrieval process will consist of activating an Overfill Recovery Tool to mobilize the sludge and the Overfill Recovery Pump to transfer the desired amount of sludge back to an EC in the basin. After removing the desired quantity of sludge, the overfill recovery line would be flushed, the Overfill Recovery Tool would be disconnected, all connections sealed, and the Overfill Recovery Tool would be abandoned in place within the STSC.

The following are key steps and components of the process:

- Sludge retrieval
- Sludge transfer
- Solids settling
- Supernate filtration
- STSC Headspace ventilation
- STSC purging and inerting
- STSC/STS cask preparation for sludge transportation and storage
- Recovery from an overfilled STSC – off-normal operation
- Process Off Gases, Emission Controls, and Emission Monitoring by Sample Extraction

These steps and associated ECRTS components are discussed in the following sections. Figure 1 shows a general process flow diagram and components of the ECRTS. Further detail about the ECRTS may be found in HNF-41051, *STP Container and Settler Sludge Process System Description and Material Balance*.

4.1 Sludge Retrieval

Sludge is currently stored underwater in the 105-KW Basin in six ECs shown in Figure 2. An EC is shown in Figure 3. Prior to sludge retrieval, the existing lid and top two sections of the ECs will be removed and replaced with new lid designed to interface with the XAGO Retrieval Tool allowing sludge to be retrieved (Figure 4). The XAGO Retrieval Tool will be used to retrieve sludge from an EC and, with the booster pump, transfer sludge from the ECs to an STSC. Sludge is retrieved from only one EC at a time.

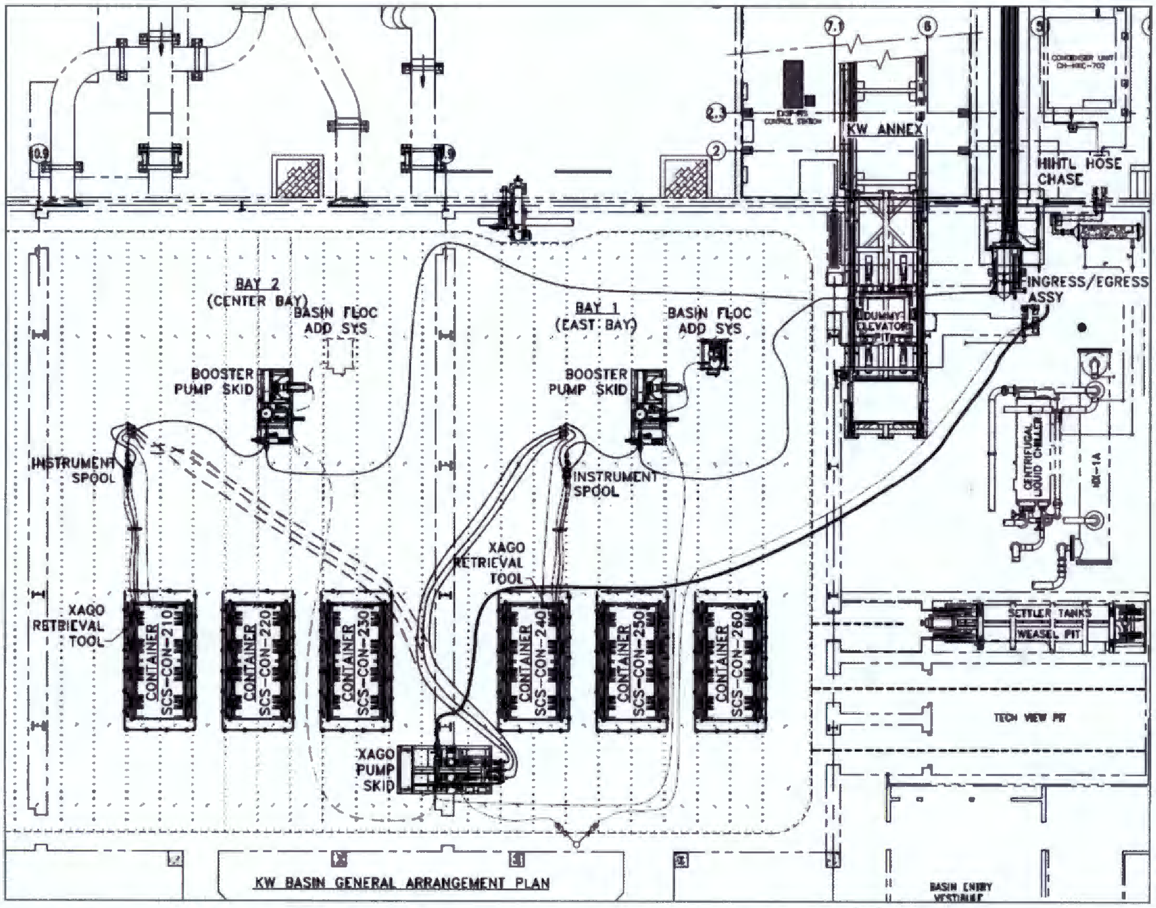

Figure 2. 105-KW Basin ECRTS General Arrangement Plan with Ingress/Egress Assembly

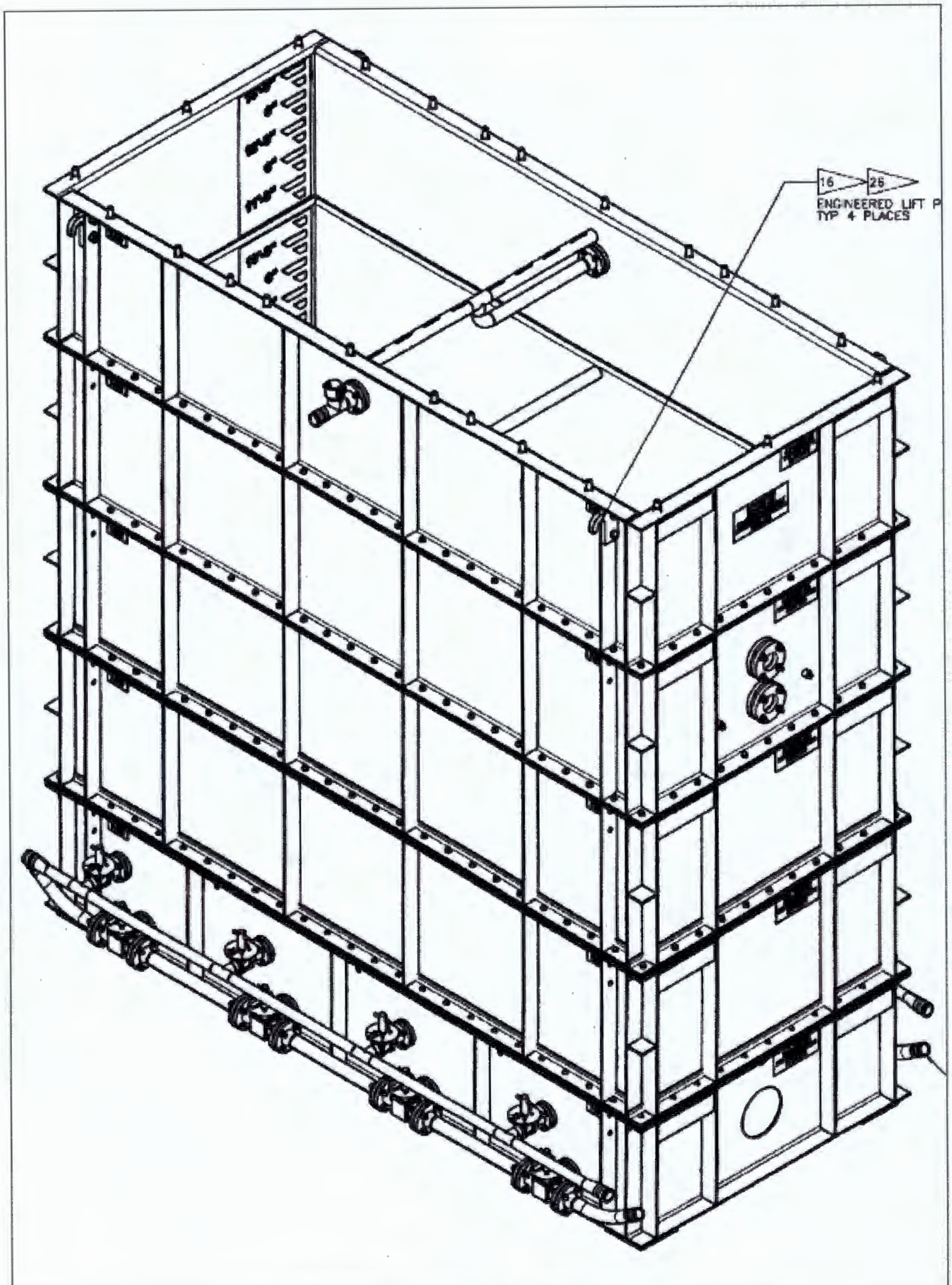

Figure 3. Engineered Container – Side View

The sludge retrieval tool is a XAGO Retrieval Tool, manufactured by XAGO Nuclear, Ltd., consisting of an adjustable annular jet pump and fluidizer (Figure 4). The retrieval tool, which has check valves in the supply hoses to prevent backflow of sludge into the IXM water service header, will be supplied with basin IXM water during use. The retrieval tool consists of an annular jet pump to provide both suction and motive force to move the slurry, a low-pressure "Coanda" fluidizer head to entrain solids at the suction end of the retrieval tool, and a set of high-pressure nozzles for use in breaking up high shear strength materials. The performance of the jet pump on the retrieval tool is adjustable by inserting or removing circular metal shims from the jet pump body during initial setup prior to installation in the basin.

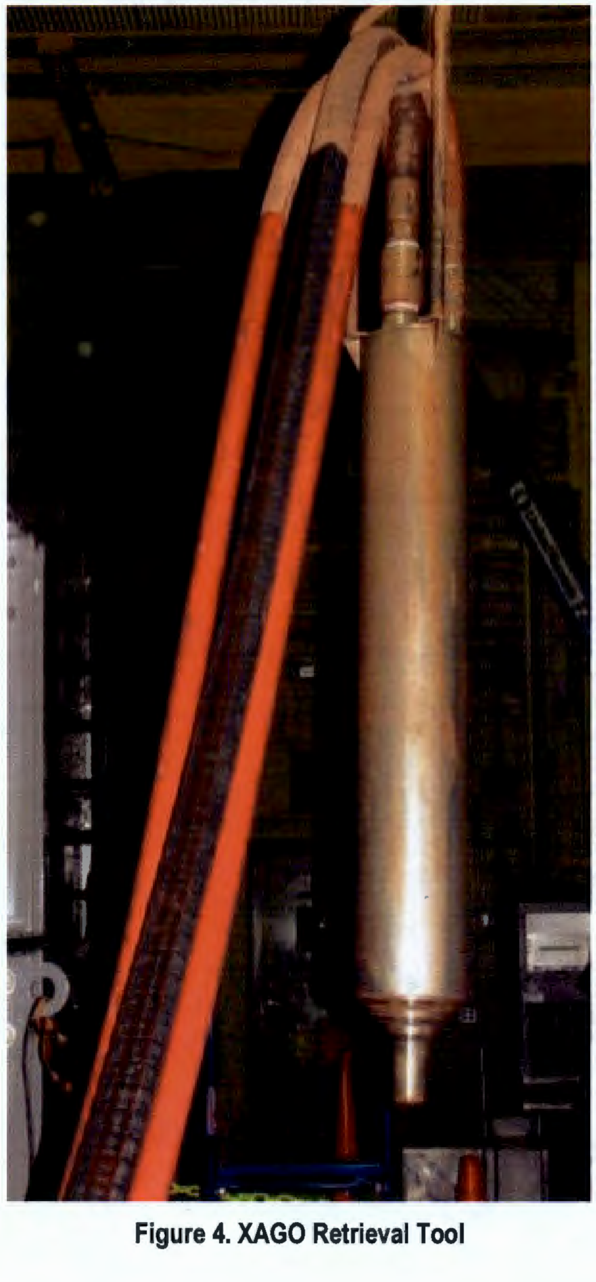

Figure 4. XAGO Retrieval Tool

4.2 Sludge Transfer

Sludge will be retrieved from an existing EC using the XAGO Retrieval Tool (Figure 4) at nominally 5 volume percent and approximately 265 L/min (70 gal/min) and transferred to a booster pump (peristaltic) via a flexible hose. Flocculant will be added to the sludge retrieved from the ECs as it is being transferred to a STSC to enhance the settling of suspended sludge particles in the STSC. The flocculant injection point during retrieval will be upstream of the pulsation dampener on the inlet side of the booster pump and has a double check valve isolation to prevent the backflow of slurry. From the booster pump, the slurry will be transferred through an ingress/egress assembly (Figure 5) which is used to transition from the underwater hose in the basin to the above basin hose-in-hose (HIH) leading to the Annex in a shielded hose chase (Figure 6). The flexible hose transitions to pipe and valves in a transfer line service box located in the Annex (Figure 1). A flexible hose connects the slurry transfer pipeline from the transfer line service box to the STSC.

Figure 5. Ingress/Egress Assembly

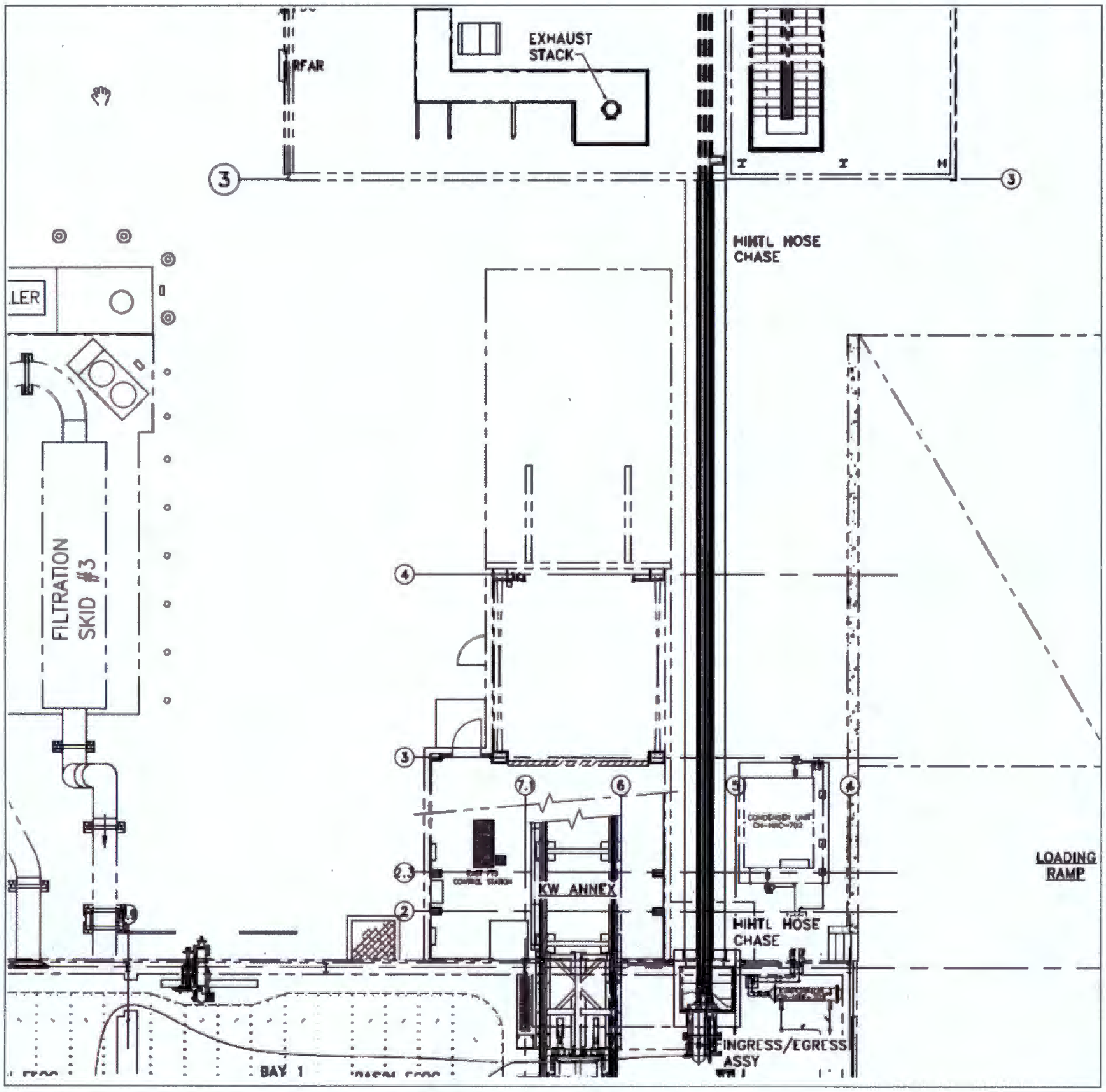

Figure 6. Hose Chase

Approximately 9 minutes would be needed for transferring the first batch of settler tank sludge in EC 230 to a STSC and about 11 minutes would be needed for transferring the first batch of KW/KE floor and pit sludge in ECs 210, 220, 240, 250, and 260 to a STSC. Following each sludge transfer, the transfer line is flushed with approximately 189.3 L (50 gal) of basin water to minimize the potential for line plugging. Subsequent batches of sludge added to the STSC will require less time to fill.

4.3 Solids Settling

After filling, the sludge slurry is allowed to settle in the STSC by gravity for at least 2 hours to concentrate the solids and clarify the supernate.

The K Basin sludge streams contain a distribution of sludge particles ranging in size from 6,350 µm (0.25 in.) to submicron and particle density ranging from 10 g/cm^3 to near 1 g/cm^3. The very small diameter

particles with low density will not have sufficient time to settle completely before excess water is removed from the STSC. Therefore, excess water removed from the STSC will contain suspended solids.
The decanted supernatant can be recirculated at 75.7 L/min (20 gal/min) through the decant pump and piping in the decant pump box, the transfer line service box, and back into the STSC. A turbidity probe will be installed in the decant line and the STSC to indicate if the suspended solids content in the decant stream is high. Flocculant can be added to the decanted supernate if the level of turbidity observed in the decanted supernate is greater than 210 nephelometric turbidity units (NTUs), which equates to approximately 90 mg/L based upon correlation of total suspended solids concentration and turbidity. Recirculation will continue until the measured turbidity of the supernate is below 210 NTUs. The decanted supernate is then transferred (approximately 75.7 L/min [20 gal/min]) through a sand filter system to remove solids before discharging the filtered STSC supernate back into the basin.

4.4 Supernate Filtration

Supernate will be removed from the STSC using a decant pump (air operated double diaphragm) equipped with a floating suction. The decant pump will be supplied with air at a maximum of 586 kPa (85 psig). The floating suction will be positioned inside the STSC, while the decant pump will be inside an enclosure (i.e. decant pump box) located on the mezzanine level of the Annex. Turbidity will be measured in the following:

- STSC
- Supernate discharge from the STSC prior to filtration by the sand filter
- Filtered supernate downstream of the sand filter before being returned to the 105-KW Basin pool

A sand filter system used to separate solids from the supernate discharge is located inside a housing positioned on the floor level of the Annex. The enclosure for the sand filter is connected to the ventilation system. The sand filter has a vent line for the air scour that connects to the ventilation system. Exhaust from the air scouring of the sand filter will be routed to the facility emission control system described in Section 4.10.

The solids captured in the sand filter will be backwashed with water taken from the discharge of the 105-KW Basin Skimmer System where the basin water undergoes filtration and ion exchange. The backwash will be through the decant line into the STSC that is being loaded following the final retrieval batch or when the differential pressure across the filter indicates a flush is warranted. An air scour unit is installed with the sand filter to assist in removing solids.

Following sand filter backwash, water from the basin Skimmer System will be added to fill the STSC to the maximum fill height. The fill and decant lines will then be allowed to gravity drain into the STSC. Then the STSC will be prepared for transportation.

4.5 STSC Headspace Ventilation

During the fill and decant operations, the headspace of the STSC will be ventilated by the Annex ventilation system that will provide adequate flow of air through the STSC to prevent a deflagration by reducing the combustible gas (hydrogen) concentration to below 25 percent of its lower flammable limit. Normal ventilation provides a nominal flow rate of 0.14 m^3/min (5 ft^3/min) for room air into the STSC headspace.

If there is a failure of the normal ventilation system, vacuum relief valves in the system will close. The resulting low airflow rate will be sensed by a flow switch, causing a solenoid valve to open, allowing the Auxiliary Ventilation System consisting of compressed gas (nitrogen) to supply nitrogen to the STSC headspace. This will provide a minimal purge flow of 0.02 m^3/min (1 ft^3/min) into the vessel to sweep the headspace continuously with nitrogen gas. Exhaust from normal ventilation and the auxiliary ventilation system will be routed to the facility emission control system described in Section 4.10.

4.6 STSC Purging and Inerting

Prior to shipment of the loaded STSC, the deflagration prevention method will be transitioned to oxygen concentration reduction. The room air supply valve will be closed and inert gas (nitrogen) will be introduced into the STSC headspace until the measured oxygen concentration of the purge outlet stream is below 1 percent by volume. The shipping cask lid will then be installed and the airspace in the sealed cask will be purged to less than 1 percent by volume oxygen. This will provide a shipping window of at least 72 hours before venting or purging is required again. Exhaust from purging and inerting will be routed to the facility emission control system described in Section 4.10.

4.7 STSC and STS Cask for Sludge Transportation and Storage

An STSC depicted in Figure 7 is an American Society of Mechanical Engineers (ASME) Section VIII stainless steel pressure vessel with a working pressure of 1,034.2 kPa (150 psig) and design life of 30 years. It is a freestanding vessel supported with a skirt. Incorporated into the design of the STSCs are nozzles for ventilation, purging, and inerting the STSC headspace. The design of the STSCs for holding sludge from EC 230 is different from the other STSCs in that there is an internal annulus provided to aid in dissipating heat with that sludge stream. Table 2 provides a summary of the STSC maximum loading restrictions based on thermal and gas generation considerations (PRC-STP-00688, *Thermal and Gas Analyses for A Sludge Transport and Storage Container (STSC) During Transportation* and PRC-STP-00241, *Sludge Treatment Project – Engineered Container Retrieval and Transfer System-Thermal and Gas Analyses for Sludge Transport and Storage Container (STSC) Storage at T Plant*) that are, in part, a function of the particle size and available surface are of uranium metal in the sludge, and estimated number of STSCs to be needed for removal of K Basins sludge. Table 1 provides the safety basis values of the uranium metal.

Figure 7. Sludge Transport and Storage Container

Table 2. STSC Loading Limits and Number Required for Sludge Removal

	EC 230 KW IWTS Settler Tank Sludge	ECs 240, 250, & 260 KE Basin Floor and Pit Sludge	EC 210 KW Basin Floor and Pit Sludge	EC 220 KW Basin Floor and Pit Sludge
Volume of sludge in EC (m^3)	3.5	18.4	4.2	1.0
Maximum volume of sludge that can be loaded into an STSC (m^3)	0.5	2.1	1.6	1.0
Estimated number of STSCs required for sludge removal	7	9	3	1

STSC liquid level and weight measurements will be used to determine when an STSC is filled. A truck scale will be used to provide the weight measurement. Liquid level measurements will be made by level detectors installed in the STSCs. Appendix A provides a quality assurance project plan and sampling and analysis plan associated with these field measurements.

After filling an STSC, weight measurements will be taken for comparison to initial tare values for final confirmation that sludge loading is within transportation limits and air release valves will be opened in the fill and decant lines to ensure complete drainage of all liquid before disconnect. The fill and decant lines and the liquid level detector cables will be manually disconnected from the top of the STSC within glove bags. The transfer lines, and nozzles on the STSC will be surveyed and, if necessary, decontaminated. The lines will then be placed into their storage area on the mezzanine in the Annex and the STSC nozzles will be capped. The STSC will be purged with nitrogen gas to displace air, then the vent line will be manually disconnected from the STSC and two sintered metal high-efficiency particulate air (HEPA) type filters will be manually installed on the STSC to provide a vent. The final STSC survey will then be conducted and the lid will be replaced back on the STS cask.

A nitrogen gas supply will be connected to a port on the side of the STS cask and the exhaust ventilation system will be connected to a port on the cask lid. The STS cask will be purged with nitrogen gas to satisfy the shipping safety requirements. The lid will then be secured and leak-tested. Once the cask has been configured as required by the shipping safety documentation, the tractor will be reconnected to the STS trailer and the shipment transported to T Plant for unloading of the STSC to temporary storage.

The STS cask with loaded STSC will be driven to T Plant where the STS cask will be received, unloaded and the STSCs stored within T Plant. Upon STS cask receipt at the T Plant railroad tunnel, the cask will be vented and purged with nitrogen gas to sweep any hydrogen gas accumulation from the airspace to ensure less than the lower flammability limits are achieved prior to offloading the STSC. After venting and purging the STS cask, the cask lid will be remotely removed and the STSC will be purged with nitrogen gas to ensure less than lower flammability limits are achieved.

After purging, the sintered metal vent filters will be removed and a vent pipe installed on the STSC. The STSC will be remotely removed from the STS cask, weighed, and lowered into a shielded storage cell using the canyon bridge crane. Each cell will have space for up to six STSCs. Each cell will hold five loaded STSCs; the sixth location can hold an STSC overpack to contain a leaking STSC if there is a STSC failure. Additionally, if there is a leak from an STSC, a sump pump in each cell can be used to transfer liquid into the STSC overpack.

While in storage at T Plant, the STSCs will be monitored annually for water loss due to evaporation and replenished with make-up water as necessary to ensure the sludge remains in a fully wet environment to prevent drying out. During storage, the headspace in the STSC will be vented via natural circulation through two vents on the STSC at different elevations. This chimney effect phenomenon is driven by the density difference between the environment and the headspace, where the gas in the environment is denser than the one in the headspace. The concentration of hydrogen will be maintained at less than 1 volume percent in the T Plant cells and in the headspace of the STSC through operation of the T Plant exhaust ventilation system. If the T Plant exhaust ventilation system is inoperable, the chimney effect of the STSC vents and the natural circulation of air through the T Plant cell cover blocks will also ensure the concentration of hydrogen is maintained at less than 4 volume percent in the T Plant cells and in the headspace of the STSC. This is because of temperature and density differential between the STSC vents and T Plant.

Accommodations for eventual retrieval of sludge from the STSCs for Phase II of the project have been incorporated into the design of the STSC by inclusion of a 66 cm (26-in.) diameter manway.

4.8 Recovery from an Overfilled STSC

If too much sludge is added to an STSC, the design of the ECRTS includes provisions whereby sludge can be retrieved from an STSC and returned to the source EC in the basin. A 10 cm (4-in.) nozzle included on the STSC for this purpose will normally be sealed and not used during STSC fill and decant operations. This nozzle will be connected to a sludge mobilization and retrieval (i.e. overfill recovery) tool (Figure 8), which is permanently installed inside each STSC (Figure 7).

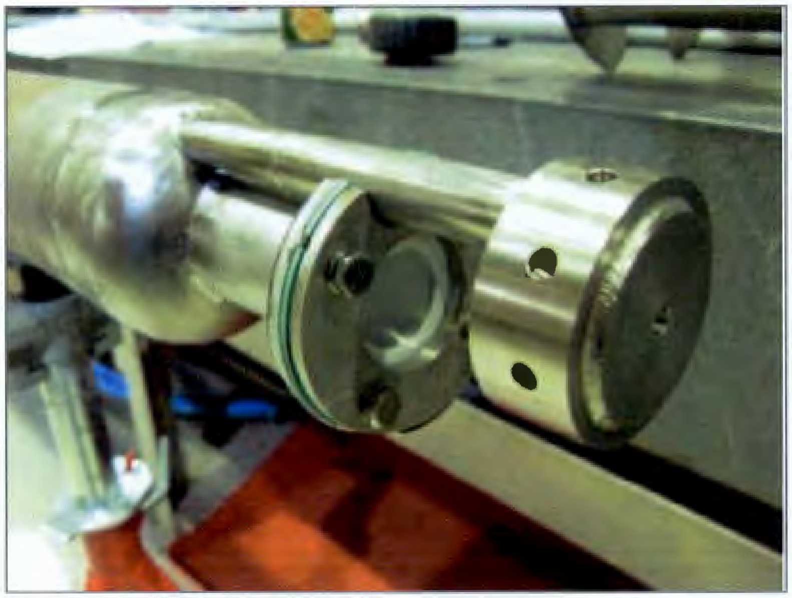

Figure 8. STSC Overfill Recovery Tool

If excess sludge needs to be removed, the Overfill Recovery Tool will be connected to a water source that provides dilution water to the tool during sludge transfer. The water source is the discharge of the 105-KW Basin Skimmer System where basin water undergoes filtration and ion exchange. The line from the 105-KW Basin Skimmer System is equipped with a check valve to prevent backflow of sludge into that system. A high-pressure pump will provide fluidization water to mobilize the sludge for transfer. The Overfill Recovery Tool will be connected to the suction of an overfill recovery pump. This overfill recovery pump is connected to the hose used for transferring sludge slurry from the XAGO Retrieval Tool and booster pump. The overfill recovery pump is normally bypassed when sludge slurry is transferred into the STSC and is only used with the Overfill Recovery Tool. The hose connection to the booster pump will be removed to enable bypassing the booster pump and the XAGO Retrieval Tool. A separate bypass hose will be connected to the slurry transfer line and an EC in the basin. The overfill recovery pump and associated instrumentation and valves will be contained in the transfer line service box within the Annex.

The retrieval process will consist of activating the Overfill Recovery Tool to mobilize the sludge and the overfill recovery pump to transfer the desired amount of sludge back to an EC in the basin. After removing the desired quantity of sludge, the overfill recovery line would be flushed, the Overfill Recovery Tool would be disconnected, all connections sealed, and the Overfill Recovery Tool would be abandoned in place within the STSC. The bypass hose would be removed and stored in the basin and the booster pump would be reconnected to the slurry transfer line. The water volume would be adjusted and the STSC would be prepared for shipment.

4.9 Process Drains and Effluent Collection and Disposition

Process drains associated with the ECRTS are for collecting any leakage from the components in the Annex, as well as the collection of water generated from activation of the fire protection system in the Annex and are shown in Figure 10.

4.10 Process Off-Gases, Emission Controls, and Emission Monitoring

Process off-gas vents on the STSCs and elsewhere in the ECRTS are routed into the Annex ventilation system upstream of the emission controls and emission sampling system. Figure 9 shows the process vents associated with the ECRTS that contribute to the overall emissions from the facility. Appendix B to this addendum is the air monitoring plan for the emissions generated by the ECRTS process vents as well as those generated by the Annex ventilation system. The ventilation system for the Annex described in Addendum 3A to the RD/RAWP (DOE/RL-2010-63-ADD3A) is also the emission controls for the off gases from the process vents. An estimation of the potential emissions generated by the process vents (potential-to-emit) is found in the Air Monitoring Plan, Appendix B.

4.11 Mock-up Testing

Full scale testing using sludge simulants in a nonradiological environment at the Hanford Site's Maintenance and Storage Facility (MASF) has demonstrated the ability to load an STSC within the required time, as described in the following documents:

- PRC-STP-TR-00412, *Test Report for Sludge Treatment Project Engineered Container Retrieval and Transfer System Integrated Retrieval and Transfer Dry Test*
- PRC-STP-TR-00514, *Test Report for Sludge Treatment Project Engineered Container Retrieval and Transfer System TRL-6 Integrated System Demonstration*

5 ECRTS Installation and 105-KW Basin Modifications

The ECRTS equipment will be installed within the 105-KW Basin and the Annex. The Annex modification includes the installation of the ECRTS components, such as transfer line service box, decant pump box, sand filter box, truck scale, crane, STSC headspace and auxiliary ventilation systems, inert gas system, heating, ventilation, and air conditioning (HVAC) system, control panels, and other support equipment. Most of the retrieval and transfer system components (except the boxes and a flocculant addition system) will be located within the 105-KW Basin.

The ingress/egress assembly as shown on Figures 2 and 5 serves as an interface structure between the HIH transfer lines and the in-basin hoses for both the transfer and decant systems and provides the wet-dry transition for those systems. Secondary containment of slurry transfer hose at the transition to the basin pool is provided by a 40.6 cm (16 in.) containment pipe that extends 0.9 m (3 ft) below the minimum K-Basin water level. Return water from the decant/filter system is routed through a 3.8 cm (1.5 in.) pipe adjacent to the 40.6 cm (16 in.) containment pipe. The ingress/egress assembly also provides a low point drain for both systems including the HIH confinement annulus. A drainpipe at the low point directs potential leaks from the primary transfer and decant system lines to leak detectors, which are also mounted to the ingress-egress assembly.

A shielded concrete hose chase runs above grade between the 105-KW Basin building and the Annex building. This structure is shown on Figure 6. It is approximately 1.5 m (5 ft) high, 1.2 m (4 ft) wide, and contains the following:

- Slurry transfer line HIH: 3.8 cm (1.5 in.) inner hose, 10 cm (4 in.) outer hose
- Filtered supernate HIH: 3.8 cm (1.5 in.) inner hose, 10 cm (4 in.) outer hose
- Spare HIH (for either slurry transfer or filtered supernate): 3.8 cm (1.5 in.) inner hose, 10 cm (4 in.) outer hose
- Hose for transferring treated 105-KW Basin water: 7.6 cm (3.0 in.)

The hoses are constructed of a synthetic rubber, reinforced with a synthetic mesh and a two-wire helix. The hose chases are heat traced and insulated for freeze protection. The hoses are designed in accordance with the applicable requirements of ASME B31.3, *Process Piping* for normal fluid service, ASTM D380-94, *Standard Test Methods for Rubber Hose*, and RMA IP-2, *The 2009 Hose Handbook.* PRC-STP-00133, *Sludge Treatment Project Engineered Container Retrieval and Transfer System, Hose-in-Hose Transfer Line Specification*, contains the requirements for the design, procurement, fabrication, testing, and inspection of the HIH transfer lines.

The existing lid and the top two sections of the ECs will be removed and placed on the basin floor in preparation for placement of the XAGO Retrieval Tool into an EC. Removal of the top two sections ensures that sufficient water cover is available to provide adequate shielding during all phases of sludge retrieval including lifting and placement of the sludge retrieval tool.

A new cover will be provided for use on the ECs with access ports for the XAGO Retrieval Tool. The new cover will minimize suspended sludge from general dispersal into the basin.

6 ECRTS Operation

Before system operation and after system installation, acceptance testing of the process and a startup readiness assessment will be performed to verify the equipment, operating procedures, and personnel are ready to commence operations.

Existing process standards, radiological controls (which include both engineered and administrative controls), and safeguards will be applied as appropriate during the work. Hazardous condition categories identified as potentially relevant to ECRTS include the following:

- Spray releases
- Hydrogen deflagration
- Oxygen-deficient atmosphere

These are addressed in more detail in PRC-STP-00731, *Sludge Treatment Project Engineered Container Retrieval and Transfer System Final Design Control Decision Report.*

6.1 Operational Steps

During the ECRTS campaign, operational steps include the following:

- Prepare the STSC for sludge transfer; connect transfer and decant hoses, ventilation system hoses, and liquid level detector cables.
- Operate the sludge retrieval system, including the sludge mobilization tool and the retrieval tool.
- Flush the HIH transfer lines between the 105-KW Basin and Annex to minimize any significant buildup of sludge.
- Operate the decant system to perform recirculation/flocculation or to decant the supernate and filter through the sand filter.
- Backwash sand filter with the effluent from a recirculating basin water treatment system to remove entrained solids and return them to STSC.
- Flush the transfer and decant lines using IXM water to minimize any significant buildup of sludge prior to disconnecting, and if necessary include the use of foam like objects during flushing to aid in

scouring buildup of contamination in the lines for as low as reasonably achievable (ALARA) purposes.

- Perform the final sludge quantity calculation in preparation for shipment.
- Disconnect transfer and decant hoses and liquid level detector cables, purge STSC/STS cask, disconnected ventilation hoses and prepare STSC for transportation to T Plant.

Sludge may be added to the ECs as necessary for removal by the ECRTS to meet the endpoint criteria.

6.2 Remote Monitoring Capability

As the Annex will not be occupied while sludge is being retrieved from the ECs in the 105-KW Basin for loading of the STSCs in the Annex, remote monitoring of system parameters and ability to control the various operational steps is included in the design. This also includes capabilities for remote radiation monitoring of conditions inside the Annex using continuous air monitors and area radiation monitors. Closed circuit television monitoring capability of the inside of the Annex loading bay is included in the final design. The remote control and monitoring station will be located inside the 105-KW Basin building.

6.3 ECRTS Process Controls

Table 3 presents a preliminary summary of key process parameters that will be monitored and recorded during ECRTS operations.

Table 3. ECRTS Process Parameters

Process Parameter	Information Measured/ Collected	Measurement Method/ Frequency	Data Range
Sludge transfer	Flow rate of retrieved sludge into STSC (nominally 265 L/min [70 gal/min])	Mass flow meter; data recorded automatically	0-378 L/min (100 gal/min), nominal 265 L/min (70 gal/min)
Sludge transfer (differential weight)	Weight of STSC, STS cask, and transport trailer (combined weight)	Weigh cells on truck scales; data recorded automatically	0-54,431 kg (120,000 lb)
Slurry transfer volume	Liquid level in STSC	Level gauge, data recorded automatically	0-254 cm (100 in.)
EC sludge level	Level markings inside engineered containers for sludge storage	Visual observation, manual recording	< 2.6 m (8.5 ft)
Decant transfer	Flow rate of supernate liquid back to basin (nominally 75.7 L/min [20 gal/min])	Mass flowmeter; data recorded during decant operations	0-189 L/min (50 gal/min), nominal 75.7 L/min (20 gal/min)
Sand filter performance	Inlet pressure, outlet pressure	Pressure gauges, data recorded during decant operations	Inlet 0-345 kPa (50 psig); Outlet 0-345 kPa (50 psig)
Overfill recovery	Flow rate of sludge back to engineered container	Mass flow meter, data recorded during overfill recovery operations	0-378 L/min (100 gal/min), nominal 265 L/min (70 gal/min)
Purging/inerting	Oxygen concentration	Oxygen analyzer	$\leq$0.1vol% O_2

7 Means of Controlling Releases to the Environment

7.1 Leaks, Spills, and Condensate

Leaks and spills from the ECRTS process within the 105-KW Basin and the transfer corridor from the 105-KW Basin to the Annex are precluded by engineering controls consisting of a design that uses a HIH concept consisting of an inner hose used to contain the sludge slurry and outer hose that will contain any leakage in the inner hose should it occur. The decant water being returned to the basin is also likewise contained in an inner hose that is contained in an outer hose, that is, complete secondary containment. Leak detectors are incorporated into the design of the above-basin transfer lines to detect a leak between the inner and outer hose as well as into the design of the transfer box, decant box, and sand filter enclosure.

Sump pumps are provided within the transfer box, decant box, and sand filter enclosure shown in Figure 1 to collect any leaks. The discharge from the sand filter sump pump is routed to the 105-KW Basin pool. The discharge from the transfer box and decant pump box sump pumps can be routed to the 105-KW Basin pool or the STSC.

Condensate from moisture separators associated with the off-gases of various process vents is not expected; however, a 75.7 L (20-gal) collection tank is provided to collect any condensate. The collected condensate would be returned to the 105-KW Basin. Water collected in drains and sumps in the change room, HEPA filter room, mechanical equipment room, and sludge loading bay within the Annex a would be collected in a 12,500 L (3,300-gal) lift station outside of the Annex building. The collected water would then be transferred to two 79,493.6 L (21,000-gal) Baker Tanks for interim storage before transfer to the Hanford Site's 200 East Area Effluent Treatment Facility/Liquid Effluent Retention Facility or other approved facility for treatment and disposal. If the Annex fire suppression system is activated, air-operated butterfly valves in each sump would open, allowing water to gravity drain to the 12,500 L (3,300-gal) exterior lift station. Figure 10 shows the drain collection system.

7.2 Emissions

Radiological emission sources include air from several vents associated with the ECRTS process and, to a lesser degree, the Annex building air space, all of which are captured by the ventilation system in the Annex and are shown in Figure 9. The potential-to-emit, means by which emissions will be monitored, and use of Best Available Radionuclide Control Technology, employing the use of HEPA filters to control emissions are described in Appendix B.

The drain lines in the facility and the lift station are vented as passive emissions through a 5 cm (2-in.) roof vent (shown in Figure 10). These drains are from: (a) non-radiological sources in the facility consisting of condensate from an air conditioning unit, air compressor, and air dryer, and (b) floor drain collection sumps within the facility that are equipped with normally closed isolation valves that isolate the sumps from the drain system that open upon actuation of the facility fire protection system. The actuation of the fire protection system is considered an upset condition.

Passive emissions from vents in the lift station and baker tanks shown in Figure 10 will also be possible. Similar to emissions vented through the 5 cm (2-in) roof vent on the Annex, these emissions would not be significant.

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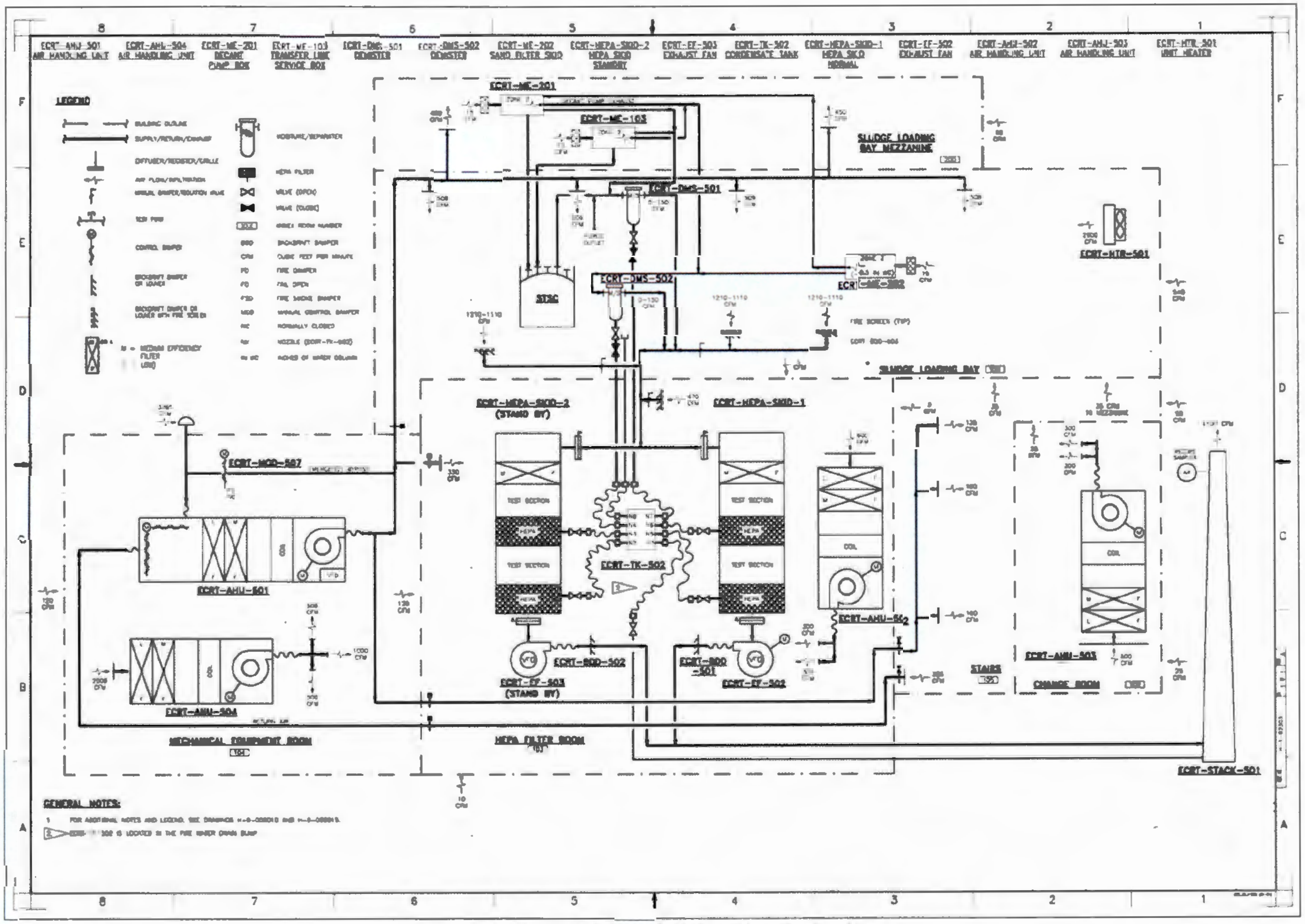

Figure 9. ECRTS Process and 105-KW Basin Annex Ventilation Flow Diagram

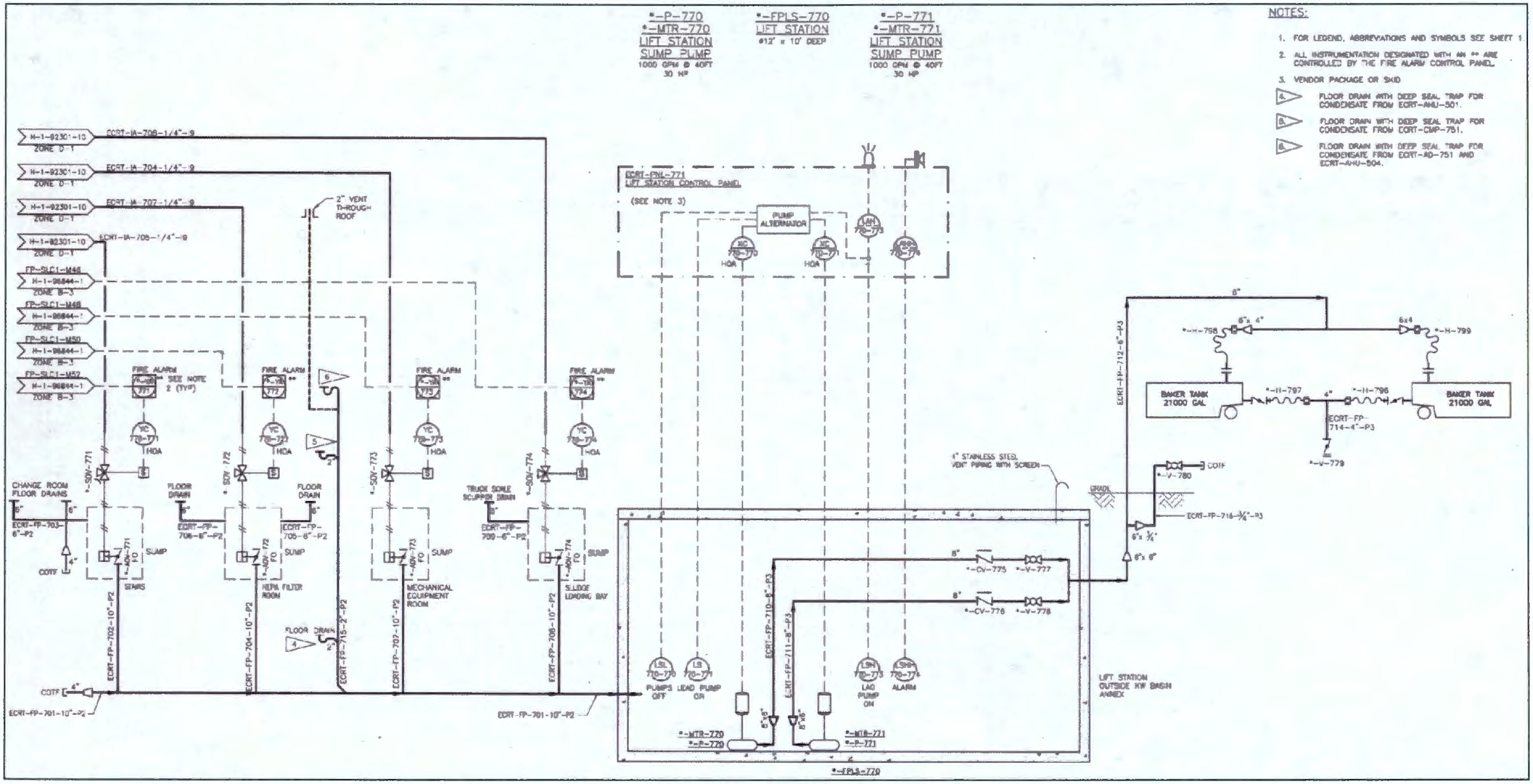

Figure 10. Drain Collection System

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Appendix A

Quality Assurance Project Plan/Sampling and Analysis Plan for Engineered Container Retrieval and Transfer System Field Measurements

Appendix Contents

Appendix Figures

Appendix Tables

Terms

105-KW	105-K West
Annex	Modified 105-K West Basin Fuel Transfer System Annex
CHPRC	CH2M HILL Plateau Remediation Company
DOE	U. S. Department of Energy
DQO	data quality objectives
DS	Decision Statement
DWFRS	Decommissioning, Waste, Fuels, and Remediation Services
EC	engineered container
ECQA	environmental compliance and quality assurance
ECRTS	Engineered Container Retrieval and Transfer System
EPA	U.S. Environmental Protection Agency
ES	Estimation Statement
PSQ	Principal Study Question
QA	quality assurance
QC	quality control
QAPjP	quality assurance project plan
SAP	sampling and analysis plan
STP	sludge treatment project
STSC	sludge transport and storage container
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*

A1 Introduction

A1.1 Purpose

The purpose of this quality assurance project plan/sampling and analysis plan (QAPjP/SAP) for Engineered Container Retrieval and Transfer System (ECRTS) field measurements is to define the strategy, process, and quality assurance/quality control (QA/QC) activities associated with the weight and level measurements taken in the Modified 105-K West (KW) Basin Fuel Transfer System Annex (Annex). Weight and level measurements will be taken during operation of the ECRTS operations during the filling of sludge transport and storage containers (STSCs) to determine the radiological source term and to verify the quantity of sludge in a STSC is within limits. The STSC loading process is described in Section 4 of this addendum.

This QAPjP/SAP establishes the quality requirements for data collection, including planning, implementation, and assessment. This QAPjP was prepared in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement; Ecology et al., 1989a) and Section 7.8 of the Action Plan (*Hanford Federal Facility Agreement and Consent Order Action Plan*, Ecology et al., 1989b). The Tri-Party Agreement Action Plan identifies EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans,* as the standard for defining the QA/QC requirements associated with actions to implement the Tri-Party Agreement, ranging from those associated with field screening activities to necessary to support comprehensive laboratory analyses.

The QAPjP/SAP is divided into the following four sections (as designated in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*), which describe the quality requirements and controls applicable to this investigation.

- **Project Management (Section A2)** – This section addresses project management, including the project history and objectives, roles and responsibilities of the participants. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs are documented.
- **Data Generation and Acquisition (Section A3)** – This section addresses all aspects of project design and implementation. Implementation of these elements ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented.
- **Assessment and Oversight (Section A4)** – This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.
- **Data Verification, Validation, and Reconciliation with User Requirements (Section A5)** – This section addresses the QA activities that occur after the data collection or generation phase of the project is completed. Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives.

A health and safety plan for this characterization activity is provided in a separate document HNF-4747, *100K Area –Minimum Safe, Health and Safety Plan* and is herein incorporated by reference.

A1.2 Scope

This QAPjP/SAP document addresses K Basins sludge that will be retrieved from the engineered containers (ECs) in the 105-K West (105-KW) Basin and loaded into STSCs in the Annex. The measurements discussed in this QAPjP/SAP will satisfy liquid level and weight information needs to control the amount of sludge added to an STSC during operation of the ECRTS to keep within limits as described in PRC-STP-00054, *STP Container and Settler Sludge Process Control Plan.*

A2 Project Management

A2.1 Project/Task Organization

CH2M HILL Plateau Remediation Company (CHPRC) is the current contractor responsible for the work scope described in this QAPjP/SAP.

The elements in this section address the management of the sample collection and analysis campaign. These elements define the project goal, so that the participants understand the goals, approach, and document planning outputs. The following elements are included:

- Organization and roles of participants
- Description of the problem or goal with background information
- Description of the activities to be performed
- Identification of the data objectives and criteria applicable to the data
- Identification of personnel training requirements
- Description of the documentation and records that will be produced

The project organization responsible for planning, coordinating, and executing characterization activities for the EC sludge as described in this QAPjP/SAP is shown in Figure A2-1.

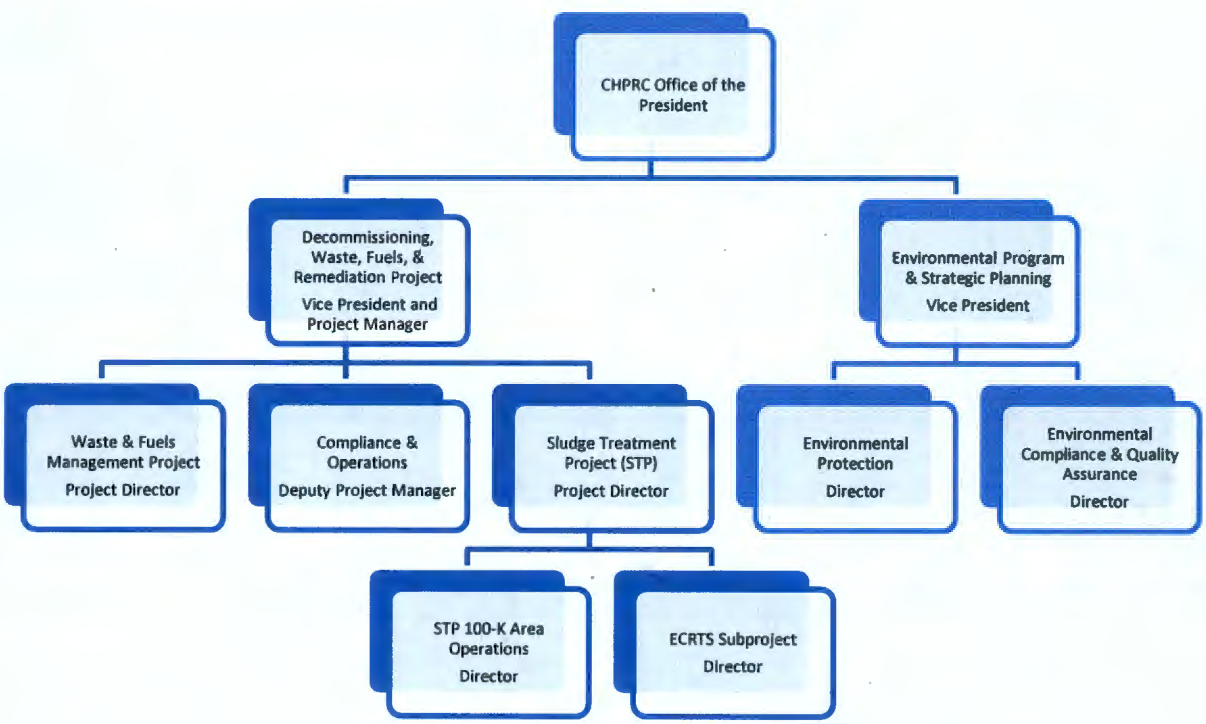

Figure A2-1. Project Organization

A2.1.1 Roles and Responsibilities:

CHPRC Office of the President

The president's office, including the Decommissioning, Waste, Fuels, and Remediation Services (DWFRS) vice president, has the responsibility to integrate site project activities including those at T Plant as needed to plan and accomplish sludge removal and storage activities in a safe and compliant manner.

Sludge Treatment Project Director

Sludge treatment project (STP) director has the responsibility to plan, schedule, and integrate project activities to execute sludge removal activities.

STP ECRTS Subproject Director

STP ECRTS subproject director has the following responsibilities:

- Provide for the design, procurement, and construction of the ECRTS.
- Establish the data quality objectives for the characterization of the sludge associated with the filling of a STSC.
- Prepare and maintain this QAPjP/SAP.
- Establish and manage interface agreements for data acquisition with 105-KW Basin operations.

STP 100-K Area Operations Director

The STP 100-K Area operations director has the responsibility for performing sludge removal operations in the 105-KW Basin and Annex including the preparations for transporting STSCs filled with sludge to T Plant. 100-K Area operations have the following responsibilities:

- Prepare the work documents governing the collection of field measurements.
- Perform field measurements.
- Perform readiness self-assessment, as required.
- Supervise personnel performing work activities.
- Transmit data from field measurements to STP ECRTS management.

DWFRS Waste and Fuels Management Project – Project Director

The DWFRS waste and fuels management project – project director provides waste management and nuclear fuel management services for the Hanford Site. This includes solid waste treatment, storage, and disposal; transportation and packaging of waste; waste minimization; and waste disposition planning.

DWFRS Compliance and Operations Deputy Project Manager

The DWFRS compliance and operations deputy project manager provides QA, radiological and occupational safety, environmental compliance, and records management functions to the DWFRS organization and reports directly to the DWFRS vice president, ensuring independence from the STP. This organizational structure helps ensure the quality assurance, environmental, safety and radiation control staff is independent from those generating project design documentation. The compliance and operations deputy project manager also interfaces with the environmental protection, and environmental compliance and QA organizations that are matrixed to support the STP.

The DWFRS compliance and operations organization has the following responsibilities:

- Interface with the U.S. Department of Energy (DOE) Richland Operations Office and regulatory agencies.
- Assess compliance with this QAPjP/SAP.
- Provide occupational radiological protection engineering and as low as reasonably achievable (ALARA) reviews.
- Provide safety and health coverage for STP operations.
- Provide QA coverage for STP design, procurement, construction, and operation activities.

CHPRC Environmental Protection

The environmental protection director and organization has the following responsibilities:

- Provide permitting and regulatory reporting services;
- Coordinate near-field environmental monitoring within CHPRC and other contractors;
- Determine if company and/or facility/project-specific policies and procedures meet applicable environmental requirements based on applicable reviews;
- Act as the regulatory point of contact for environmental compliance;
- Perform periodic management reviews of environmental activities and functions against organizational goals and commitments, and directs actions for continuous improvement;

CHPRC Environmental Compliance and Quality Assurance

The environmental compliance and quality assurance (ECQA) director has responsibility for implementation of the ECQA program through quality engineering, surveillances, and assessments that analyze and assure the effectiveness of the implementation of the ECQA program based on those QA requirements that are derived from environmental regulations and the Tri-Party Agreement (Ecology et al., 1989a). The ECQA director and staff have access to the appropriate management levels in order to plan, assess, and identify improvements to the quality systems. The ECQA director ensures the direct support of quality and the effective quality program implementation associated with environmental activities.

The ECQA organization has the responsibility to implement the CHPRC ECQA program by providing quality engineering support, QA assessments, and environmental quality reviews of environmental activities undertaken by CHPRC. Quality engineering support activities include consultations with project engineers and staff personnel to ensure that quality requirements derived from environmental regulatory documentation are being built-in during planning stages of projects. ECQA activities include audits, and surveillances to verify that quality requirements have been met.

A2.2 Problem Definition

The operation of the ECRTS to remove sludge from the 105-KW Basin in STSCs for transportation to and storage at T Plant requires controls be put in place to limit the amount of sludge loaded into a STSC based on type of sludge. An earlier data quality objectives (DQO) document, HNF-36985, *Data Quality Objectives for Sampling and Analysis of K Basin Sludge*, was prepared to support the design and operation of sludge removal process, storage of sludge pending treatment, treatment, and storage of the treated sludge pending transfer to a national repository for disposal. Sludge being removed from the

105-KW Basin has been characterized per the DQO above and is reported in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Volume 2.*

The design of the ECRTS including the STSCs is described in HNF-41051, *Sludge Treatment Project Container and Settler Sludge Process System Description and Material Balance*. Limits of the amount of sludge that can be loaded in an STSC are based on transportation or storage limitations that are driven by radiological source term inventory or thermal and hydrogen gas generation considerations (PRC-STP-00754, *STP ECRTS Setpoint Determination*). Field measurements and calculations will be made to determine the STSC payload to ensure these limits are not exceeded.

The applicable principal study questions (PSQs) and the associated estimation statements (ESs) and/or decision statements (DSs) with these field measurements is provided in Table A2-1. The data needed to address each of the ESs and DSs are listed in Table A2-1.

Table A2-1. Principal Study Questions and Estimation/Decision Statements

Principal Study Question	Estimation/Decision Statement	Data Needed
PSQ 1: Does sufficient characterization information exist about sludge in the ECs to support safe compliant STSC loading and transfer to T Plant in accordance with HNF-40475 and DOE/RL-2001-36?	**ES 1**: Values for critical parameters that affect STSC loading will be determined. For the identified critical parameters, both a bounding and design basis value will be established as necessary. **DS 1**: It will be determined if an STSC loaded with EC sludge meets loading and transportation requirements.	Type of sludge loaded in a STSC. STSC sludge loading limits as defined in PRC-STP-00754. Weight of an STSC and liquid level in the STSC.
PSQ 2:Does sufficient characterization information exist about EC sludge to support acceptance of the sludge at T Plant in accordance with HNF-EP-0063?	**ES 2**: Values for critical parameters that affect the acceptance of EC sludge will be determined. For the identified parameters, both an average and a bounding value will be established. **DS 2**: A determination will be made whether STSCs loaded with EC sludge meet acceptance requirements.	Generator-supplied documentation demonstrating compliance with the requirements of HNF-EP-0063, except as allowed with profile sheet approval.

Sources:

HNF-40475, *Functional Design Criteria Sludge Treatment Project Phase 1*

DOE/RL-2001-36, *Hanford Sitewide Transportation Safety Document*

HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*

PRC-STP-00754, *STP ECRTS Setpoint Determination*

A2.3 Task Description

The task is measuring the liquid level in an STSC and measuring the weight of an STSC for computing the quantity of sludge in an STSC associated with the PSQs identified in Table A2-1 to ensure it within limits for the type of sludge loaded in the STSC. Table A2-2 describes what information needed to satisfy the characterization needs associated with PSQs identified in Table A2-1.

Table A2-2. STSC Payload Characterization Needs

Data Needed	Population Parameter	Source or Approach
Type of sludge, i.e. from what EC is the sludge is being loaded into an STSC	Source of sludge being transferred	Campaign plan and procedures.
Liquid level in a STSC	Inches	Measure liquid level in a STSC prior to adding sludge to an STSC. Measure liquid level in a STSC during and/or after adding sludge to an STSC.
Weight of an STSC	Pounds or kilograms	Measure the weight of an STSC: • Prior to adding water/sludge • After adding water to a known liquid level • After adding water/sludge to a known liquid level
Quantity of sludge in STSC	Pounds	Calculation using differential weight of an STSC before loading it with sludge and after loading it with sludge corrected for buoyancy.
Radionuclide content	Curies	Calculation as necessary based on waste profile approval using characterization data from sludge sampling and analysis (HNF-SD-SNF-TI-015).
Quantity of uranium metal	Grams per unit volume	Calculation as necessary based on waste profile approval using characterization data from sludge sampling and analysis (HNF-SD-SNF-TI-015).
Uranium metal surface area	Square meters of surface area	Calculation as necessary based on waste profile approval using previous laboratory analysis of uranium metal particles. Bounding assumptions for particle size.
Fissile grams equivalent	Grams	Calculation as necessary based on waste profile approval using characterization data from sludge sampling and analysis (HNF-SD-SNF-TI-015).
Reaction rate of uranium metal	Grams of uranium corroded per second per surface area	Literature information

Source: HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook, Volume 2, Sludge*

A2.4 Quality Objectives and Criteria

The quality objective of the field measurements is to determine the amount of sludge in a STSC. This is performed by measuring the weight of STSCs and liquid level in the STSCs as described in PRC-STP-00054, *Sludge Treatment Project Container and Settler Sludge Process Control Plan.* The quality criteria associated with these measurements are described in PRC-STP-00754, *Sludge Treatment Project Engineered Container Retrieval and Transfer System Setpoint Determination.*

A2.5 Training and Certifications

Training will be provided to those performing field measurements associated with this QAPjP/SAP. Procedures for transferring EC sludge to a STSC will be based on development testing at the Maintenance and Storage Facility that involved operations staff as part of a learning and optimization process. Operators will be trained to operate the ECRTS process systems and training records will be maintained in accordance with CHPRC training and QA programs.

A2.6 Documentation and Records

Project documentation, including this QAPjP/SAP, will be controlled, maintained, and distributed in accordance with a quality assurance program based on 10 CFR 830.120, "Nuclear Safety Management," "Scope." Implementing procedures and work documents identify records and establish record access control, protection, retention, and record management requirements.

All records generated by this QAPjP/SAP will be maintained by the STP until they are archived. The STP ECRTS subproject manager is responsible for ensuring the project file is properly maintained. All documents and records are retained in archives indefinitely. Data from field measurements described herein that can be used as objective evidence for preparing project closure reports under this *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) action and those required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed according to the requirements of Section 9.0, *Documentation and Records*, of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

A3 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure STP ECRTS characterization methods for liquid level and weight measurements. These measurements and their use in controlling the loading of an STSC are described in more detail in PRC-STP-00054, *STP Container and Settler Sludge Process Control Plan.* Measurements of liquid level and weight support the calculation of the quantity of sludge in an STSC. The differential weight of an STSC (i.e. change in weight of an STSC with a given level of liquid and its weight with sludge/liquid at the same level) indicates the quantity of sludge in an STSC, and is equal to the buoyant weight of the sludge solids. If the quantity of sludge in an STSC exceeds limits based on the EC of origin, excess sludge will be removed using an overfill recovery tool and process.

A3.1 Liquid Level Measurements

Measuring the liquid level in a STSC is performed continuously by radar level instrumentation that is installed on each STSC that transmits liquid level information to a control panel used in computing the volume of sludge added to an STSC. Figure A3-1 provides an example of an STSC liquid level measurement device.

Figure A3-1. Example STSC Liquid Level Measurement Device

A3.2 Weight Measurements

Measuring the weight of the STSC both empty, full of water, and with sludge is used to determine the differential weight that is a measure of the quantity of sludge added to an STSC. Weight measurements will be performed by using a truck scale equipped with a load cells that measure the weight of the STSC, cask, and the trailer on which they stand. Measuring the weight of the STSC, contents of the STSC, cask, and trailer will be performed continuously and used to determine quantity of sludge added to an STSC.

A3.3 Material and Data Tracking/Management

Each STSC will have a unique sequential tracking number. Data will be entered on a traveler document identifying the type of sludge and equivalent settled volume of sludge computed from the weight and liquid level measurements. Travelers will be managed according to administrative procedures for the handling of STSC data packages. These traveler documents supplement applicable operating procedures. Manifests for shipping radioactive material will be used documenting the transfer of sludge to T Plant.

A3.4 Laboratory Analysis Requirements

No laboratory work is specified by this QAPjP/SAP or the process control plan thus no laboratory related requirements are included.

A3.6 Quality Assurance Requirements

The design and fabrication or procurement of components used for weight and liquid sludge level measurements, procedures used to perform measurements, and the qualification and training of individuals performing these measurements will be consistent with QA requirements derived from a quality assurance program based on 10 CFR 830.120, "Nuclear Safety Management," "Scope."

A3.7 Non-Direct Methods of Information Gathering

Non-direct methods of information gathering consist of performing calculations.

A4 Assessment and Oversight

The following section addresses the activities for assessing the effectiveness of STP implementation of sludge characterization activities and associated QA and QC activities. The purpose of assessment is to ensure that this QAPjP/SAP is implemented as prescribed.

A4.1 Assessments and Response Actions

Audits, assessments, and self-assessments are performed consistent with a CHPRC QA program established to integrate assessment planning. The following sections describe the assessments that will be used for the project, their frequency and type, and the management of corrective actions identified in those assessments.

If circumstances in the field dictate the need for additional assessment activities, the activities would be performed and recorded according to approved procedures. Deficiencies identified by these assessments will be reported according to existing programmatic requirements. The project's line management chain coordinates the corrective actions and deficiencies according to the QA program, the corrective action management program, and the associated procedures for implementing these programs.

A4.1.1 Management Assessment

Management assessments are scheduled per an integrated assessment plan. The ECRTS subproject has management assessments scheduled before starting basin operation and at the completion of operations. The goal and performance of the management assessment will be directed at determining the effectiveness of operation preparation and the completion of work activities. Senior and first-line management immediately responsible for the work being performed will be responsible for planning and performing the management assessment, resolving quality problems, considering opportunities for improvement, and ensuring corrective actions are identified.

A4.1.2 Independent Assessment

Independent assessments are scheduled per an integrated assessment plan. The assessments that are performed as part of startup readiness reviews are also considered a type of independent assessment. This startup readiness review will be conducted before starting operation of the ECRTS. Readiness checklists will be completed by STP engineering and K Basins operations, demonstrating the design completion, sufficiently documented equipment testing, trained personnel availability, and approved operating procedures issuance.

A4.1.3 Surveillance

Surveillances are scheduled per an integrated assessment plan. The ECRTS subproject will schedule surveillances on such tasks as design, testing, equipment fabrication, and operations. Surveillances are conducted to verify conformance with specific requirements and evaluate the adequacy and effectiveness of activities affecting the quality of work processes and products. Personnel who are technically knowledgeable about, and not directly responsible for, the work under surveillance will perform these surveillances.

A4.1.4 Corrective Action Management

Corrective actions will be taken if any condition adverse to quality is detected during an audit or assessment. The cause of any adverse condition that affects compliance with the requirements listed in this QAPjP/SAP will be promptly determined and action taken to preclude its occurrence.

Consistent with CHPRC policy, all personnel have the responsibility and authority to stop work when an employee believes that an identified situation exists that places the employee, their coworker(s), contracted personnel, or the environment at risk. QA personnel have the authority to stop work in response to a significant finding during an audit or assessment.

Corrective actions will be managed by CHPRC processes to enable personnel to initiate a condition report for any quality-related condition or process improvement evaluation. This includes conditions that may require analysis, trending, cause determination, or identification and tracking of corrective actions. The process then allows for appropriate management of the corrective actions.

A4.2 Reports to Management

STP QA or CHPRC environmental compliance and QA personnel will report audit, surveillance, and assessment results to STP management. Corrective actions will be documented, tracked, and reported consistent with current CHPRC work processes.

A5 Data Verification, Validation, and Reconciliation with User Requirements

Data quality for this project will be assessed in three steps:

- **Data Verification** is the process of evaluating the completeness, correctness, and conformance/compliance of a specific dataset against the method, procedural, or contractual requirements.
- **Data Validation** is an independent review of a process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the quality of the entire dataset viewed as a whole.
- **Reconciliation with User Requirements** is the evaluation of the data to determine if they meet the objective of the project (i.e., the data are of the right type, quality, and quantity to support their intended use), which, in this case, is primarily the objective of acceptance of STSCs with sludge for storage at the T Plant.

A5.1 Data to be Reviewed

The data to be verified, validated, and assessed are: (a) direct measurements of water level in an STSC and weight of an STSC filled with water and sludge, and (b) non-direct measurements consisting of calculations. The goal of data verification is to ensure and document that the data are what they purport to be, that is, that the reported results reflect what was actually done and meet applicable requirements. When deficiencies in the data are identified, then those deficiencies will be documented for the data user's review and, when applicable, resolved by corrective action. The focus of data validation is determining the data quality in terms of the accomplishment of measurement quality objectives.

Responsibility for data review, verification, and validation lies with assigned technical reviewers. The technical reviewer will have technical expertise in the subject matter to be reviewed to a degree at least equivalent to that needed to perform the original work. Records of data review and verification will be managed according to administrative procedures for the handling of STSC data packages.

A5.2 Data Verification and Validation

The liquid level and weight measurements, and calculations determining the quantity of sludge in an STSC, will be verified and validated as follows.

A5.2.1 Data Verification

A verification of direct field measurements of weight and liquid level data will be performed by someone other than the individual performing the measurement. This can include the process-cognizant engineer or QA engineer that determines and documents that the measurements are correct and conform to specified requirements. Verification of non-direct measurements (calculations) will be done by someone other than the individual who prepared the calculation, in accordance with the CHPRC ECQA program.

A5.2.2 Data Validation

Validation of direct field measurements will be performed to confirm the measurements were made by using calibrated equipment and may be done at the same time and those performing data verification.

A5.3 Reconciliation with User Requirements

The verified and validated data will be used to determine conformance to pre-established loading limits described as PSQs in Table A2-1. If loading limits are exceeded a review will be performed by cognizant individuals to determine if an overfill recovery process should be employed or an "accept-as-is" determination be made and documented.

Any validated data that is shown not to conform to the measurement quality objectives will be dispositioned as a non-conformance and managed in accordance with the CHPRC QA program.

A6 References

10 CFR 830.120, "Nuclear Safety Management," "Scope," Code of Federal Regulations. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-sec830-120.xml.

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HNF-4747, 2013, *100K Area – Minimum Safe, Health and Safety Plan*, Rev. 8, CH2M HILL Plateau Remediation Company, Richland, Washington.

HNF-36985, 2009, *Data Quality Objectives for Sampling and Analysis of K Basin Sludge*, Rev. 3, CH2M HILL Plateau Remediation Company, Richland, Washington.

HNF-40475, 2010, *Functional Design Criteria Sludge Treatment Project Phase 1*, Rev. 1, CH2M HILL Plateau Remediation Company.

HNF-41051, 2012, *Sludge Treatment Project Container and Settler Sludge Process System Description and Material Balance*, Rev. 11, CH2M HILL Plateau Remediation Company, Richland, Washington.

HNF-EP-0063, 2011, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 16, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/HNF-EP-0063_Rev16_041111_Website.pdf.

HNF-SD-SNF-TI-015, 2013, *Spent Nuclear Fuel Project Technical Databook, Volume 2, Sludge*, Rev. 21, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-STP-00054, 2012, *Sludge Treatment Project Container and Settler Sludge Process Control Plan,* Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-STP-00754, 2012, *Sludge Treatment Project Engineered Container Retrieval and Transfer Setpoint Determination*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Appendix B

K Basins Interim Remedial Action Air Monitoring Plan for Operation of the Engineered Container Retrieval and Transfer System at the 105-K West Basin and 105-K West Basin Annex

Contents

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Terms

105-KW	105-K West
ARAR	applicable or relevant and appropriate requirement
BARCT	best available radionuclide control technology
EC	engineered container
ECRTS	Engineered Container Retrieval and Transfer System
HEPA	high-efficiency particulate air
MEI	maximally exposed individual
PTE	potential-to-emit
TEDE	total effective dose equivalent

B1 Introduction

This appendix describes the screening of potential radiological and nonradiological emissions generated from the Engineered Container Retrieval and Transfer System (ECRTS) and emitted through the 105-K West (105-KW) Basin Roof Vents and 105-KW Basin Annex stack during the removal of sludge from the 105-KW Basin. This includes a description of how emissions will be monitored to ensure they are within limits.

The final design of the ECRTS is described in the earlier portion of this ADDENDUM. Figure B1 depicts the sources of air emissions within the 105-KW Basin Annex.

Sludge retrieval from the engineered containers (ECs) in the 105-KW Basin will be performed underwater and the transfer of that sludge to the 105-KW Basin Annex will utilize a hose-in-hose transfer system. The ECRTS activities and emissions potential associated with operations in the 105-KW Basin is restricted by what is described in DOE/RL-97-28, *Radioactive Air Emissions Notice of Construction Fuel Removal for 105-KW Basin*. Emission monitoring and controls associated with these activities in the 105-KW Basin will remain unchanged.

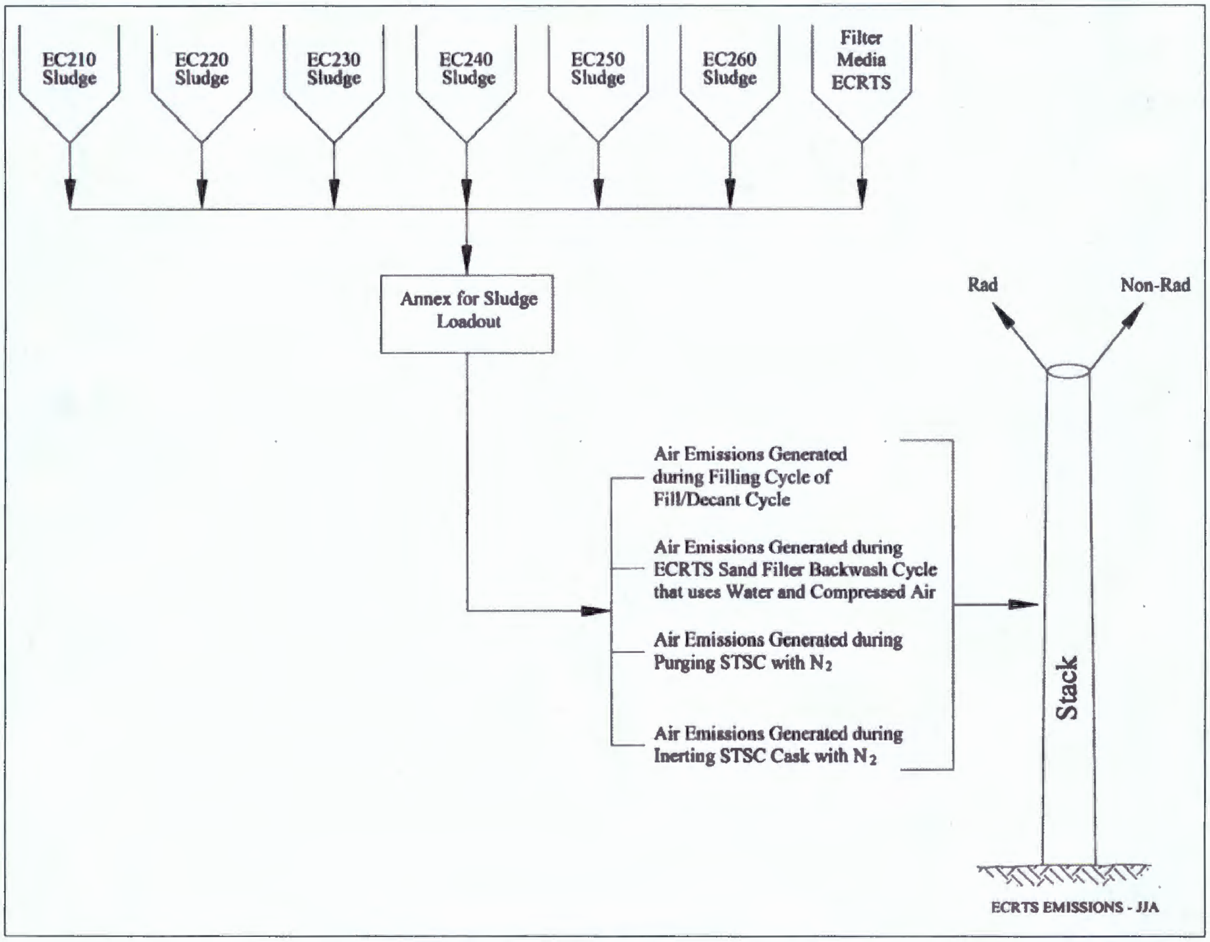

Figure B1. 105-KW Basin Annex Emission Sources

B2 Radiological Air Emissions

The applicable or relevant and appropriate requirements (ARARs) associated with radiological emissions from the ECRTS emitted to the environs through the 105-KW Basin Annex stack are as follows:

- 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities"
- WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides"
- WAC 246-247, "Radiation Protection – Air Emissions"

The substantive requirements derived from these ARARs are as follows:

- Radionuclide emissions will be determined and effective dose equivalent values to members of the public calculated using agency approved methods and models.
- Combined radionuclide emissions from the Hanford Site cannot exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/year or greater.
- Emissions will be monitored in accordance with approved methods and quality assurance practices.
- Emissions will be controlled in accordance with best available radionuclide control technology (BARCT).

B3 Criteria or Toxic Air Emissions

The ARARs associated with nonradiological emissions from the ECRTS emitted to the environment through the 105-KW Basin Annex stack are as follows:

- WAC 173-400, "General Regulations for Air Pollution Sources"
- WAC 173-460, "Controls for New Sources of Toxic Air Pollutants"

The substantive requirements derived from these ARARs include standards for toxic emissions, visible emissions, fallout, fugitive emissions, odors, emissions detrimental to persons or property, sulfur dioxide, concealment and masking, and fugitive dust.

The potential emissions of target organic compounds (i.e. semivolatile and volatile toxic air pollutants) associated with the removal of sludge in the six ECs in the 105-KW Basin using the ECRTS and exhausted through the 105-KW Basin Stack were estimated (ECF-100KR2-2012-0083, *New Source Review KW Basin ECRTS*). This estimate determined the mass of toxic air pollutants potentially discharged to the environment, in terms of pounds per year. This estimate concluded that the emissions meet small quantity emission rates for toxic air pollutants listed in WAC 173-460-150, "Controls for New Sources of Toxic Air Pollutants," "Table of ASIL, SQER and de Minimis Emission Values." Therefore, use of treatment technologies for controlling emissions of toxic air pollutants is not necessary.

B4 Radiological Airborne Source Information

A graded approach in applying emission monitoring and emission control requirements has been adopted in the regulations listed in Section B2 and is based on a facility's potential-to-emit (PTE). The PTE is defined as "the estimated radionuclide release rates shall be based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal" (40CFR61.93.(b)(4)(ii), "National Emission Standards for Hazardous Air Pollutants," "Emission monitoring and test procedures"). The PTE associated with the operation of the ECRTS has been conservatively estimated for the removal of sludge in each of six ECs in the 105-KW Basin Pool and then totaled as the sludge removal project is expected to be completed in one year. The PTE associated with all six ECs has been conservatively estimated to be 23 curies per year, as shown in Table B1 (ECF-100KR2-2012-0005, *Potential-to-Emit Calculation for KW Basin Annex for ECRTS*).

The distance to the maximally exposed individual (MEI) is 8,900 m (29,200 ft) north northwest of the 100-K Area (DOE/RL-2006-29, *Calculating Potential to Emit Radiological Releases and Doses*). This location represents the nearest unrestricted public access and therefore the MEI for purposes of assessing potential public exposure due to airborne releases. The total unabated emissions in terms of PTE to the receptor from ECRTS operations could result in up to 0.69 mrem/year total effective dose equivalent (TEDE) to the MEI (ECF-100KR2-2012-0005, *Potential-to-Emit Calculation for KW Basin Annex for ECRTS*). The total abated emissions to the receptor from ECRTS operations could result in up to 3.93E-03 mrem/year TEDE to the MEI, as shown in Table B1 (ECF-100KR2-2012-0005, *Potential-to-Emit Calculation for KW Basin Annex for ECRTS*).

B5 Emission Controls

The estimated TEDE received by the MEI because of unabated emissions from operations of the ECRTS is greater than 0.1 mrem/yr. Therefore, BARCT standards listed under WAC 246-247-110 (18), "Radiation Protection – Air Emissions, Appendix A — Application Information Requirements" are incorporated as applicable into the design of the 105-KW Basin Annex exhaust ventilation system. The exhaust system will use a demister for separation of any moisture in the off gas from the process vents and two stages of high-efficiency particulate air (HEPA) filters, in series, for filtering the exhaust before being discharged to the environment (Section 5.6 of ADDENDUM 3A).

The HEPA filters used to filter the exhaust will be leak tested in the field prior to startup of the ECRTS and annually thereafter, as needed. The challenge aerosol for in-place leak testing of installed HEPA filter systems shall be a polydispersed liquid aerosol having an approximate light-scattering droplet size distribution as follows:

- 99 percent less than 3 μm diameter
- 50 percent less than 0.7 μm diameter
- 10 percent less than 0.4 μm diameter

The HEPA filter housings will also be equipped with differential pressure gauges across each stage of HEPA filters. The housings will be periodically monitored for changes in differential pressures and annually calibrated thereafter, as needed.

B6 Monitoring

The estimated TEDE potentially received by the MEI due to unabated emissions from the ECRTS is greater than 0.1 mrem/yr. Therefore, samples of the 105-KW Basin Annex stack emissions will be collected and measured based on the applicable principles of measurement described in 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Appendix B, "Test Methods," Method 114. As a minimum, emissions of those radionuclides identified in Table B1 (cesium-137, strontium-90, plutonium-239, plutonium-240, and americium-241) will be sampled monthly and characterized quarterly for estimating emissions and determining conformance to the BARCT standard for emissions, and to the 10 mrem/year standard for the Hanford Site. Monthly samples will be analyzed for total alpha radioactive content and gross beta/gamma radioactive content, providing monthly results. The sampling frequency of monthly may be extended if the ECRTS is in the midst of loading a sludge transport and storage container. In that case, emissions will be sampled at the next available window of opportunity, i.e. before loading the next container.

Emission rates will be kept relatively constant at 113.3 m^3/min (4,000 ft^3/min) using variable frequency drive motors with the exhaust fans programmed to maintain a constant rate of exhaust flow out the stack. Therefore, because stack flows will be relatively constant, flow rates will checked periodically by measuring velocity and computing the volumetric flow rate before startup of the ECRTS and annually thereafter, as needed.

Table B1. Estimated Characteristics of Radiological Emissions Associated with the ECRTS

	Case 1 KW IWTS Settler Tank Sludge EC 230 (Vol. 3.5 m^3)	**Case 2 KE Basin Floor and Pit Sludge ECs 240, 250, and 260 (Vol. 18.4 m^3)**	**Case 3 KW Basin Floor and Pit Sludge EC 210 (Vol. 4.2 m^3)**	**Case 4 KW Basin Floor and Pit Sludge EC 220 (Vol. 1.0 m^3)**	**Total (Sum of Cases 1-4) (Vol. 27.1 m^3)**
PTE, curies per year	4.84	16.7	1.04	0.44	23.02
PTE TEDE to MEI, mrem/yr	0.47	0.14	0.05	0.03	0.69
Abated Dose to MEI, mrem/yr	2.83E-03	7.55E-04	2.30E-04	1.17E-04	3.93E-03
Isotopes that Contribute					
>10% PTE TEDE to the MEI	Strontium-90, plutonium-239, plutonium-240, americium-241	Strontium-90, plutonium-239, plutonium-240, americium-241	Cesium-137, strontium-90, plutonium-239, plutonium-240, americium-241	Strontium-90, plutonium-239, plutonium-240, americium-241	
>0.1 mrem/yr PTE TEDE to the MEI	Plutonium-239, americium-241				
>25% of the TEDE to the MEI after controls	Americium-241	Americium-241	Americium-241	Americium-241	

IWTS = integrated water treatment system

B7 References

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml.

61.93, "Emission monitoring and test procedures."

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ECF-100KR2-2012-0083, 2012, *New Source Review KW Basin ECRTS*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington

WAC 173-400, "General Regulations for Air Pollution Sources," *Washington Administrative Code*, Olympia, WA. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-400.

WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," *Washington Administrative Code* Olympia, WA. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460.

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WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, Olympia, WA. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-480.

WAC 246-247, "Radiation Protection – Air Emissions," *Washington Administrative Code*, Olympia, WA. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-247.

246-247-110, "Appendix A — Application Information Requirements."