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Double-Shell Tank Process Waste Sampling Subsystem Definition Report

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

CH2MHILL

Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC06-99RL14047

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J. H. Rasmussen

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Abstract:

This report defines the Double-Shell Tank (DST) Process Waste Sampling Subsystem (PWSS). This subsystem definition report fully describes and identifies the system boundaries of the PWSS. This definition provides a basis for developing functional, performance, and test requirements (i.e., subsystem specification), as necessary, for the PWSS. The resultant PWSS specification will include the sampling requirements to support the transfer of waste from the DSTs to the Privatization Contractor during Phase 1 of Waste Feed Delivery.

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TERMS

DQO	data quality objective
DST	double-shell tank
HLW	high-level waste
HSTD	<i>Hanford Site Technical Baseline Database</i>
LAW	low-activity waste
PFP	Plutonium Finishing Plant
PWSS	DST Process Waste Sampling Subsystem
RPP	River Protection Project
SST	single-shell tank
WESF	Waste Encapsulation and Storage Facility
WFD	Waste Feed Delivery

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DOUBLE-SHELL TANK PROCESS WASTE SAMPLING SUBSYSTEM DEFINITION REPORT

1.0 INTRODUCTION

1.1 PURPOSE

This report defines the Double-Shell Tank (DST) Process Waste Sampling Subsystem (PWSS). This subsystem definition report fully describes, and identifies the system boundaries of the PWSS. This definition provides a basis for developing functional, performance, and test requirements (i.e., subsystem specification), as necessary, for the PWSS. The resultant PWSS specification will include the sampling requirements to support the transfer of waste from the DSTs to the Privatization Contractor during Phase 1.

1.2 EXECUTIVE SUMMARY

The Double-Shell Tank Process Waste Sampling Subsystem provides sampling support for the Waste Feed Delivery (WFD) Project, as a subsystem of the DST System. This report describes the PWSS and establishes the system boundaries, as a basis for establishing functional, performance, and test requirements, as part of the subsystem specification development process. As a subsystem of the DST System, with functions specific to the DST system, the PWSS is treated here-in as a unique sampling system, separate from other existing samplings, to allow full development of the subsystems functions and requirements without prejudice or prematurely conceived design solutions. This assumes that the PWSS will assume sampling functions for Phase 1 DST's for the duration of the WFD Project.

1.3 OVERVIEW

The system description of the PWSS presented in this document was developed to establish the boundaries of the PWSS, based on *the Tank Waste Remediation System Architecture Tree*, HNF-4208, and the *Functional Analysis for Double-Shell Tank Subsystems*, HNF-5136, for the River Protection Project (RPP). The boundaries provide a complete and accurate description of the system at the subsystem level. This subsystem definition report will provide a starting point for subsequent work analyzing functional, performance, and test requirements necessary to develop a subsystem specification for the PWSS.

Sampling is defined herein as removing liquid, solid, or gaseous contents from a tank or vessel within the DST System for examination, measurement, analysis, or testing. While some observations or measurements of DST samples may be performed in the field, many tests and analyses require laboratory capabilities not found within the tank farms. Therefore, the PWSS consists of structures and components that obtain samples of DST contents, perform any field observations or analyses of the samples, and deliver samples to laboratories.

The role of the PWSS is to sample in-process waste undergoing storage, preparation and staging in the DST System for delivery to the high-level waste (HLW) and low-activity waste (LAW) vitrification plants. Some of the functions identified for the PWSS are similar to those currently being performed by the existing Tank Waste Sampling System, as defined in HNF-4208. The PWSS will utilize the capabilities of the existing Tank Waste Sampling System where feasible. The PWSS may include additional hardware to perform functions not within the capabilities of the existing Tank Waste Sampling System. Such capabilities may include obtaining samples of liquids and slurries during mixer pump operations, obtaining samples that are maintained at constant temperature from capture through delivery and analysis, obtaining surface samples that can reliably detect a floating organic layer, and obtaining real-time field measurements from pumped sample loops.

This document defines the interfaces and boundaries of the PWSS. Subsequent specification development efforts will include functional analyses and performance analyses that will identify and specify any functional and performance requirements applicable to the PWSS that are not satisfied by current capabilities of Tank Waste Sampling System. Sampling requirements are driven by data requirements. These requirements will be driven primarily by requirements for information about physical and chemical properties needed to control the waste retrieval process. The PWSS specification will be developed concurrently with the development of flowsheets, process control strategies, and interface control documents, and prior to final analytical data and process monitoring requirements being defined by the Privatization Contractor for waste feed certification. Details of the final PWSS may vary from those described here as a consequence of emerging requirements.

1.4 ORGANIZATION

The remainder of this document is organized into sections, as follows.

- Section 2.0 establishes the PWSS as a subsystem of the DST System and shows the relationship between the DST System and the Tank Waste Sampling System.
- Section 3.0 describes the interfaces and support between the PWSS and other subsystems.
- Section 4.0 provides a cursory look at the functions performed by the PWSS.
- Section 5.0 describes the PWSS and discusses the rationale for the PWSS description provided.
- Section 6.0 provides the system definition and conclusions.
- Section 7.0 lists the references cited.
- Appendix A lists and describes the critical issues that must be resolved to fully define the PWSS.

2.0 BACKGROUND

The *TWRS Mission Analysis Report*, HNF-SD-WM-MAR-008, established the Tank Farm System and functions to safely store waste in the 200 Area tank farms and to prepare those wastes for disposal. As shown on Figure 2-1 taken from the TWRS Architecture Tree, HNF-4208, Rev. 0, the Tank Farm System consists of four major systems including the DST System, Single-Shell Tank (SST) System, the Tank Waste Sampling System, and the Master Monitor Control System.

Figure 2-1. Tank Farm System Architecture Tree.

The Tank Waste Sampling System shown in Figure 2-1 is an existing system that obtains core, grab, auger, and vapor samples in support of safe storage of tank waste, interim stabilization, evaporator operation, and Waste Feed Delivery (WFD) process development needs from locations throughout the Tank Farm System including SSTs, DSTs, miscellaneous underground storage tanks, inactive miscellaneous underground storage tanks, and ventilation ducts. Specifically, the function Sample and Characterize Tank Farm System Waste (see Hanford Site Technical Baseline Database [HSTD] function number tsd.1.2.5.5) describes what the Tank Waste Sampling System must do to support the RPP mission. The technical portion of the function description states:

Samples of waste in a double-shell tank (DST) or single-shell tank (SST) are obtained and shipped to a laboratory for analysis of selected physical and chemical properties. Sampling includes accessing the tank, obtaining a sample, restoration of tank containment, placement of the sample in a shipping container, and shipment to a laboratory. This is a cyclic process. A cycle begins when the need for a sample is identified and continues until the sample is delivered to the laboratory receiving area, analyzed, and the results are assessed (where applicable).

Consequently, the Tank Waste Sampling System may not provide the capabilities required to support the WFD operational mission. A functional analysis has not yet been performed for the

PWSS system. A function analysis of the PWSS is necessary to determine the requirements on the subsystem, and therefore the potential suitability of the existing Tank Waste Sampling System in meeting yet to be determined requirements. While the existing Tank Waste Sampling System now performs many functions currently perceived for the PWSS, additional functional capabilities may be required for in-process sampling to support the dynamic WFD mission.

A DST System architecture to accomplish the receipt, storage, preparation, and transfer functions was established in HNF-4208. As shown in Figure 2-2, the DST System architecture was further decomposed in HNF-4208 to include subsystems such as the PWSS.

The *System Specification for the Double-Shell Tank System*, HNF-SD-WM-TRD-007, established DST System functions, system-level requirements and interfaces applicable to the first phase (Phase 1) of the RPP mission described in the HNF-SD-WM-MAR-008. The purpose of the DST System, according to the DST System specification, is to receive, store, and treat (prepare) waste and to transfer it to the Phase 1 Privatization Contractor, as shown in the DST system functional flow block diagram (Figure 2-3). As shown on Figure 2-3, the mission system analysis resulted in functions to “Sample and Characterize Tank Farm System Waste” for the waste stored in both the 200 East Area and the 200 West Area DSTs. These sampling functions are currently being performed by the Tank Waste Sampling System. HNF-5136 developed a functional decomposition that identified in-process sampling functions, associated with the Prepare Waste functions, which are shaded in Figure 2-3. The role of the PWSS is to perform these in-process sampling functions for waste being prepared and staged for delivery to the Privatization Contractor.

The waste stored, prepared, staged, and transferred in the DSTs as part of the described DST System functions includes tank waste already in the DSTs and waste received from the SST System and other onsite generators. HNF-SD-WM-TRD-007 describes the flow of waste in and out of the DST System as shown in the DST interface diagram (Figure 2-4). As shown in Figure 2-4, waste samples are transferred from the DST System to external non-RPP laboratories. These external laboratories may include 222-S, the Waste Sampling and Characterization Facility, the Pacific Northwest National Laboratory, and other laboratories designated by RPP or the Privatization Contractor.

Figure 2-2. Double-Shell Tank System Architecture Tree.

Figure 2-3. Double-Shell Tank System Functional Flow Block Diagram. (Sheet 1 of 2)

Figure 2-3. Double-Shell Tank System Functional Flow Block Diagram. (Sheet 2 of 2)

Note: 1) Store Waste Functions are multi-mode and are performed continuously.
 2) Shaded functions incorporate lower tier sampling functions.
 3) Information on this drawing will be incorporated in a future update of HNF-5136.

DST320-1.CVS

Figure 2-4. Double-Shell Tank System Interface Diagram.

3.0 DOUBLE-SHELL TANK PROCESS WASTE SAMPLING SUBSYSTEM INTERFACES

Interfaces between the PWSS and other systems are shown diagrammatically in Figure 3-1. These interfaces are described below.

Figure 3-1. Double-Shell Tank Process Waste Sampling Subsystem Interfaces.

3.1 DOUBLE-SHELL TANK UTILITIES SUBSYSTEM INTERFACE

The DST Utilities Subsystem provides the electrical power, raw/potable water, and service/instrument air to support the systems that are used to maintain safe storage within the DSTs; to process, stage, and transfer LAW and HLW feed to the Privatization Contractor; and to

receive and manage routine waste receipts. The following DST Utilities Subsystems are provided by the System Breakdown Structure in HNF-4208:

- DST Electrical Power Subsystem
- DST Raw Water Subsystem
- DST Potable Water Subsystem
- DST Service Air Subsystem.

These subsystems have been further subdivided to identify lower level subsystems/components and are addressed in the *Double-Shell Tank Utilities Subsystem Specification*, HNF-4157.

A general description of the PWSS interface to the DST Utilities Subsystem is as follows.

- The PWSS interfaces with the DST Electrical Power Subsystem by receiving power from the DST Electrical Power Subsystem to energize instrumentation loops, signal conditioners, input/output devices, programmable logic controllers, operator interface stations, computers, servers, data storage devices, motors, actuators, lights, fans, and sampling devices. The heating, ventilation, and air conditioning (HVAC) systems to maintain samples at constant temperature may be electrically powered. Consideration may be given to a self-contained on-board power supply for portability, flexibility, and reliability reasons, during PWSS design development.
- The PWSS interfaces with the DST Raw Water Subsystem by using small quantities of water for decontamination or flushing. During development of the PWSS specification, consideration may be given to a self-contained on-board water supply for portability, flexibility, and reliability reasons. The core sampling subsystem uses a self-contained, LiBr-traced water supply to detect potential intrusion of head fluid or flush water into the samples. Consideration will be given to implementing similar self-contained, LiBr-traced water systems, during PWSS design development.
- The PWSS does not require an interface to the DST Potable Water Subsystem.
- The PWSS may interface with the DST Service Air Subsystem by using small quantities of compressed air for controls or actuators. During development of the PWSS specification, consideration may be given to a self-contained on-board service air supply for portability, flexibility, and reliability reasons.
- The PWSS may interface with the DST Instrument Air Subsystem by using small quantities of compressed air for controls or actuators. Consideration may be given to a self-contained on-board instrument air supply for portability, flexibility, and reliability reasons, during PWSS design development.

3.2 DOUBLE-SHELL TANK CONFINEMENT SUBSYSTEM INTERFACE

The DST Confinement Subsystem provides the physical tank structure and other barriers that confine the waste within the DST System. The PWSS interfaces with the DST Confinement

Subsystem by gaining access to the tank waste through risers and other tank confinement system penetrations. The limited number and sizes of risers impose limitations on the configuration of the PWSS.

- Gaining access for sampling results in air inleakage into the DST Confinement Subsystem via an open riser. In some cases, access for sampling is obtained by removing a blind flange or other cover sealing an unused riser such as a sludge measurement port. In other cases, access must be obtained by temporarily removing an installed component such as a liquid-level gauge from a riser. In either case, gaining access for sampling results in increased airflow through the riser.
- The PWSS removes tank contents from the DST Confinement Subsystem via existing risers.
- The PWSS introduces LiBr-traced water into the tank waste in the DST Confinement Subsystem. Small quantities of water are used as hydrostatic head fluid to exclude tank contents from the core sampling drill string when the samples are being inserted and removed. Small amounts of flush and decontamination water may be used by PWSS subsystems. This water will drain into the tank via the sampling riser.
- The PWSS introduces nitrogen gas into the DST Confinement Subsystem tank headspace via the sampling riser. Nitrogen is used to cool the rotary core sampling drill bit. Nitrogen also is used to pressurize drill strings to exclude tank waste from the drill string.

3.3 DOUBLE-SHELL TANK VENTILATION SUBSYSTEM INTERFACE

The DST Ventilation Subsystem maintains the DST Confinement Subsystem headspace at a negative pressure and provides airflow that dilutes flammable and toxic gases and cools the tank contents. The PWSS interfaces with the DST Ventilation Subsystem directly when obtaining vapor samples and indirectly via the DST Confinement Subsystem when sampling liquids and solids.

- The PWSS removes small amounts of air from ventilation ducts or tank head-space regions when obtaining vapor samples. Samples may be obtained from permanently installed test ports or by inserting temporary sample collection devices into ducts and tank risers. Some DST Monitor and Control Subsystem gas monitoring devices such as Standard Hydrogen Monitoring System cabinets incorporate permanently installed vapor sampling ports, which may be used by the PWSS.
- The PWSS interacts indirectly with the DST Ventilation Subsystem by introducing air and nitrogen into the DST Confinement Subsystem via risers. Nitrogen is introduced primarily by the core sampling subsystem to cool rotary core sampling drill bits and to pressurize drill strings to prevent intrusion of waste. Ambient air flows into the DST Confinement Subsystem whenever risers are opened to gain access for sampling.
- The capabilities and dynamic behavior of the DST Ventilation Subsystem impose limitations on the configuration of the PWSS. The PWSS must be configured to limit

unacceptable transients and upsets in the DST Ventilation Subsystem when breaching tank confinement. The limitations of the DST Ventilation Subsystem may restrict the timing of sampling activities performed by the PWSS.

3.4 DOUBLE-SHELL TANK MONITOR AND CONTROL SUBSYSTEM INTERFACE

The DST Monitor and Control Subsystem obtains data from sensors throughout the DST System and distributes the data to monitoring, control, and recording devices. The control functions of the DST Monitor and Control Subsystem send signals to valves, actuators, variable-frequency drives, and other control devices that operate the WFD process. The DST Monitor and Control Subsystem may monitor certain parameters of the PWSS. However, the chief interaction between the DST Monitor and Control Subsystem and the PWSS occurs during the functional analysis, performance analysis, specification development, and design stages of the WFD project when tradeoffs are evaluated between sampling and in situ instrumentation to obtain process control information.

- The DST Monitor and Control Subsystem may monitor sensor outputs from the pumped sampling and analysis loop subsystem, as will be described later in section 5.0. If the pumped sampling and analysis loop subsystem is employed to provide real-time pumpability status information, such as detecting localized elevated suspended solids concentrations, an interface with the DST Monitor and Control Subsystem may be required to implement pump shutdown or diluent injection logic. This interface cannot be fully defined until process control strategies and flowsheets have been developed.
- The DST Monitor and Control Subsystem may provide tank level or other data to the pumped sampling and analysis loop subsystem. Depending on performance requirements identified during future flowsheet and process control strategy development, interlocks may be implemented to automatically shut down or flush the pumped sampling and analysis loop subsystem on low tank liquid level, utilizing signals from the DST Monitor and Control Subsystem.
- DST Monitor and Control Subsystem components such as liquid-level transducers occasionally must be temporarily removed to gain access to tank contents via the risers on which the instruments are mounted. This applies to subsystems of the PWSS.

Because many parameters can be measured by either sample analysis or instrumentation, trade-off studies may be performed to evaluate which parameters are best measured by instrumentation and which parameters should be measured by sample analysis. Real-time measurements of waste characteristics under actual tank conditions are preferred whenever reliable, robust in situ sensors can be deployed at acceptable cost. Many parameters such as temperature, pressure, and liquid level are well suited to in situ instrumentation. For parameters, including most chemical constituents, radionuclides, vapor pressure, particle size, and crystallization behavior, there may be few alternatives to sampling and laboratory analysis. However, for many properties such as solids spatial distribution, presence of floating organic layers, viscosity, and vapor composition, either approach may have specific strengths and limitations. This optimization activity cannot proceed further until the process control strategy and performance analyses are developed.

3.5 DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY SUBSYSTEM INTERFACE

The DST Maintenance and Recovery Subsystem provides repair parts, calibration, maintenance, and other support to the PWSS. The DST Maintenance and Recovery Subsystem assists in the extrication and recovery of stuck drill strings and other PWSS components that fail during sampling activities.

The PWSS may be called upon to sample liquids in a DST annulus, miscellaneous underground storage tanks, inactive miscellaneous underground storage tanks, or other location as part of maintenance and recovery actions in response to actual or suspected leaks or equipment failures.

3.6 DOUBLE-SHELL TANK WASTE SAMPLING SYSTEM INTERFACE

While there may be shared equipment, further study may be needed after requirements have been developed.

3.7 LABORATORY (NON-TANK FARM SYSTEM) INTERFACE

The 222-S Laboratory and other designated laboratories receive, analyze, and archive samples obtained by the PWSS. The laboratories decontaminate sample shipping casks and return them to the PWSS.

- PWSS sample containers, shipping devices, and other sample handling systems must be compatible with laboratory sample handling and analysis systems.
- The temperature-controlled sample handling and transport system will require new functions and architectures at the laboratory to ensure that the samples remain at tank temperature during laboratory handling and analysis.
- The laboratory decontaminates sample shipping casks and returns the cleaned casks to the PWSS for reuse. The interface occurs at the laboratory shipping/receiving area.

3.8 CENTRAL WASTE COMPLEX (NON-TANK FARM SYSTEM) INTERFACE

Operation of the PWSS generates solid waste. These wastes include contaminated drill string segments, plastic sleeving, adhesive tape, and other items discarded in conjunction with sampling activities. The PWSS is not expected to generate new, unique waste types requiring significant changes to functions or architectures of the Central Waste Complex.

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4.0 DOUBLE-SHELL PROCESS WASTE SAMPLING SUBSYSTEM FUNCTIONS

The DST System functions that support the Phase 1 WFD mission are described in HNF-5136. The second-tier DST functions portrayed in Figure 2-3 are further broken down into sub-functions in HNF-5136 and are described below as they pertain to the PWSS. The function of the PWSS is to obtain information about DST waste composition and properties as needed to carry out the WFD mission. These functions will be analyzed and defined further during the development of the PWSS specification.

4.1 STORE WASTE IN WEST AREA DOUBLE-SHELL TANKS FUNCTION

Sampling supports subsidiary functions of the Store Waste functions in HNF-5136. According to HNF-5136, Sample DST Waste Composition is a fourth tier function of the Control DST Waste Composition function, which, in turn, is a third tier function of the Store Waste in West Area DSTs function. Sampling also is required before wastes are transferred to support waste compatibility evaluations and to establish dilution ratios and other transfer-related parameters. For transfers performed as part of the WFD mission, pretransfer sampling is included in the Prepare Waste functions preceding each WFD-related transfer. For other transfers, sampling is included in the Sample and Characterize Tank Farm System Waste function, which is performed by the Tank Waste Sampling System.

4.1.1 Control Double-Shell Tank Waste Composition Function

4.1.1.1 Waste Characteristics. The Control DST Waste Composition function applies to solids, liquids, and gases.

4.1.1.2 Waste Location. The waste of concern to the Control DST Waste Composition function includes the entire contents of the DST, including liquids, solids, and headspace vapors. While this includes both the surface and subsurface regions, no unique surface sampling requirements currently exist.

4.1.1.3 Type of Data. Laboratory analyses are required to characterize the chemical composition, density, energetics (fuel) content, moisture content, radiological source term, fissile material distribution, vapor generation, and corrosivity properties of the DST contents. Data requirements have been evaluated and documented using the Data Quality Objective (DQO) process. Applicable DQOs include the following:

- *Tank Safety Screening Data Quality Objective, WHC-SD-WM-SP-004, (Safety Screening DQO)*
- *Data Quality Objectives for Tank Farms Waste Compatibility Program, HNF-SD-WM-DQO-001, (Compatibility DQO)*

- *Data Quality Objective to Support Resolution of the Flammable Gas Safety Issue, HNF-SD-WM-DQO-004, (Flammable Gas DQO).*

The following DQOs may be applied to selected tanks to establish the regulatory status of the tank waste stored in DSTs:

- *Data Quality Objectives for Regulatory Requirements for Dangerous Waste Sampling and Analysis, HNF-SD-WM-DQO-025, (Dangerous Waste DQO)*
- *Data Quality Objectives for Regulatory Requirements for Hazardous and Radioactive Air Emissions Sampling and Analysis, HNF-SD-WM-DQO-021, (Air Emissions Regulatory DQO)*

Because safety issues related to ferrocyanide, organic solvent, organic complexant, and toxic vapor hazards are closed or nearing closure, no additional sampling is anticipated to address these issues. No special surface samples are anticipated to fulfill the Store Waste function. While the Compatibility DQO, HNF-SD-WM-DQO-001, includes pumpability parameters, these are not of concern to the Control DST Waste Composition function. Transfer-specific parameters are of concern only when transfers are contemplated and are discussed in Section 4.4.1.2.

4.1.1.4 Tank Condition. There are two categories of tank conditions of concern to the PWSS. The two categories of tank conditions of particular concern to the upcoming PWSS specification development effort are those tanks undergoing mixing and those tanks not undergoing mixing. Tanks undergoing mixing may require more complex and robust sampling hardware than tanks not undergoing mixing. Because the Control DST Waste Composition function applies to phases of the WFD mission at times as long as the DST contains any waste, this function may apply to both tanks undergoing mixing and tanks not undergoing mixing.

4.1.1.5 Sample Handling and Transport. DST waste samples will be transported to 222-S or another designated laboratory for analysis. Temperature control during sample handling and transport may be considered when the tank temperature is above ambient and if the waste is expected to contain significant quantities of dissolved salts. Solids formed by crystallization during handling and transport cannot be distinguished from solids that were originally present in the tank when the sample was obtained. Ambient temperature sample handling and transport under these conditions may lead to incorrect conclusions about the quantity and characteristics of solids actually present in the tank waste. Sample temperature controls may not be required when the tank being sampled is near ambient temperature, when the supernate is sufficiently dilute that crystallization of dissolved salts is not anticipated, or when such solids formation will not materially affect the conclusions drawn from the sample data. The actual need for temperature controlled sample handling and transport has not been established, and needs further study. See Appendix A.

4.2 STORE WASTE IN EAST AREA DOUBLE-SHELL TANKS

The Store Waste in East Area DSTs function is similar to the Store Waste in West Area DSTs function with few exceptions. To minimize redundancy, the discussion below is limited to those exceptions.

4.2.1 Control Waste Composition Function

A number of East Area DSTs are used as feed tanks for the 242-A Evaporator. Additional requirements to support 242-A Evaporator operation are described below. This is an ongoing activity that is being supported by the Tank Waste Sampling System.

4.2.1.1 Type of Data. Additional data requirements applicable to 242-A Evaporator operation are documented in *242-A Evaporator Data Quality Objectives*, HNF-SD-WM-DQO-014, and ECN 653669 (Evaporator DQO). The data needed per the Evaporator DQO require laboratory analysis.

4.2.1.2 Waste Characteristics. Waste transfers to the 242-A Evaporator consist of liquids or flowable slurries. The waste generally is not saturated with dissolved salts and may be at or above ambient temperature.

4.2.1.3 Waste Location. The waste of concern for waste transfers is located in one or more bulk layers within a DST. The Evaporator DQO, HNF-SD-WM-DQO-014, requires screening of the waste for the presence of a bulk surface organic layer to avoid entraining unacceptable amounts of organic solvents into the evaporator feed. Grab samples obtained near the waste surface have been determined to be acceptable for organic screening for operation of the 242-A Evaporator per the Evaporator DQO.

4.2.1.4 Tank Condition. Samples are obtained from tanks not undergoing mixing.

4.3 PREPARE WASTE IN WEST AREA DOUBLE-SHELL TANKS FUNCTION

The Prepare Waste in West Area DSTs function consists of steps to dissolve soluble solids, suspend insoluble solids, and dilute the DST contents in preparation for transfer. The functional decomposition in HNF-5136 assumes that the Prepare Waste in West Area DSTs function is essentially similar to the Prepare Waste in East Area DSTs function. Because the Prepare Waste in East Area DSTs function is more extensive and complex than the Prepare Waste in West Area DSTs function, the discussion of Prepare Waste in East Area DSTs in Section 4.4 is assumed to encompass the PWSS functions required to support the Prepare Waste in West Area functions.

The waste stored in West Area DSTs may be transferred through the cross-site transfer line. This does not apply to waste stored in East Area DSTs. On the other hand, waste stored in East Area DSTs may be transferred to the Privatization Contractor, whereas waste stored in West Area DSTs are not anticipated to be transferred through this new line without first being staged in an East Area DST. While pretransfer sampling requirements will be similar, these differences

will be taken into account when evaluating the laboratory results and when transfer-related parameters such as dilution ratios, preheating, etc. are specified.

4.4 PREPARE WASTE IN EAST AREA DOUBLE-SHELL TANKS FUNCTION

The Prepare Waste in East Area DSTs function is further decomposed in HNF-5136. Only those activities that involve the PWSS are discussed below.

4.4.1 Mobilize and Suspend Insoluble Waste Within East Area Double-Shell Tanks

The functional decomposition for the Mobilize and Suspend Insoluble Waste Within East Area DSTs in HNF-5136 identifies a "Sample Source Tank HLW" function. Process control samples are obtained to monitor the progress of the waste mobilization step. When the waste preparation step is complete, HNF-5136 identifies a Sample Prepared HLW function to obtain pretransfer samples to verify compatibility and establish transfer-related parameters such as required dilution ratios before the waste is transferred to HLW staging tanks or other DSTs.

4.4.1.1 Process Control Samples. Process control samples are envisioned in HNF-5136 to be obtained as part of an iterative process in which diluent is added to the waste, and mixer pumps operate to suspend the solids. The suspended solids are sampled to determine the extent to which the solids are suspended, evaluate the uniformity of the solids suspension, and assess whether further blending and/or diluent additions are required. Samples of the unsuspended heel also may be required. This process is repeated until the solid suspension is ready to be transferred to an HLW staging tank or to another DST.

4.4.1.1.1 Type of Data. DQOs or process control plans have not yet been developed for waste preparation process control sampling. It is anticipated that parameters of interest may include quantity of suspended solids as a function of location within the tank (i.e., the spatial distribution of solids), composition of suspended solids, slurry rheological properties, composition of the supernate, and the amount and characteristics of unsuspended solid heels. In situ instrumentation may be considered to measure the quantity of suspended solids, rheological properties, and spatial distribution of solids. In situ density measurements may provide a rough estimate of the extent to which solids are dissolved in the supernate. Laboratory analysis will be required for those parameters that cannot be adequately measured by in situ instrumentation.

The composition of headspace gases and vapors will be measured to ensure that the process complies with flammable gas and regulatory requirements. Real-time measurements of key constituents such as hydrogen and ammonia using the DST Monitor and Control System will provide the primary process control input for this function. However, sampling to measure species of regulatory concern may be performed to verify compliance with regulatory requirements.

4.4.1.1.2 Waste Characteristics. Process control samples primarily will be obtained from flowable slurries containing the suspended solids. Less frequent samples of unsuspended solid heels and headspace gases and vapors also may be required.

4.4.1.1.3 Tank Conditions. Process control strategies, flowsheets, and process control plans have not yet been finalized to identify the conditions under which process control samples must be obtained. Samples of suspended slurries may be obtained during mixer pump operation to assess the effectiveness of the mobilization step and to measure the spatial distribution of solids. Sampling after mixer pump shutdown may be adequate if the quantity of fast-settling solids is not consequential. Source tank wastes are being sampled and evaluated per the Tank T HLW DQO, HNF-1558. These evaluations include combining settled solids and supernate to predict waste behavior during retrieval. These data may lessen the need for and reliance on process control samples, and may provide the information needed to determine whether the waste must be sampled during mixer pump operation.

4.4.1.2 Pretransfer Samples. The prepared wastes are transferred to HLW staging tanks or to other DSTs at the conclusion of the waste preparation step. Sampling is performed before transfer, to provide information for compatibility assessments, and to evaluate other transfer-related parameters.

4.4.1.2.1 Type of Data. The Compatibility DQO, HNF-SD-WM-DQO-001, lists the data required for compatibility assessments. Laboratory analysis is required. The Compatibility DQO addresses liquids containing no more than 5 percent solids. Additional data may be required for suspensions containing over 5 percent solids. No DQO has been prepared to identify transfer-related parameters for HLW slurries. In addition to the waste compatibility assessment, process control information may be required to evaluate pumpability parameters, establish the amount of dilution required, determine the locations of phase boundaries, etc. *Flowsheets, process control strategies, and process control plans may establish any additional information requirements applicable to each transfer.* Parameters of interest may include settling behavior, rheological properties as a function of slurry solids loading, spatial distribution of solids, and solids content as a function of temperature.

Limited real-time data may be required to assess pumpability parameters such as solids loading and the spatial distribution of solids at the time of transfer, because the waste may be mobilized for transfer weeks or months after it has been sampled for compatibility analysis. Real-time data may be required to gauge the spatial distribution of solids in the waste being transferred to guard against localized slugs of solids that could plug the transfer line. In situ instrumentation provided by the DST Monitor and Control Subsystem may be preferable for such measurements.

Information about the composition and transfer-related properties of candidate HLW and LAW source tank waste is being developed in accordance with the Tank T HLW DQO, HNF-1558, Tank T LAW DQO, HNF-1796, and Equipment DQO, WHC-SD-WM-DQO-008. Samples for these evaluations are being obtained by the Tank Waste Sampling System. The behavior of slurries prepared by combining liquid and solids samples in the laboratory is being evaluated. To the extent that robust, conservative dilution ratios and other parameters can be established by these laboratory studies, there may be less need for and reliance on pretransfer sampling.

4.4.1.3 Waste Characteristics. Waste transfers consist of flowable slurries. Salt cakes, settled sludges, and crusts do not participate in waste transfers unless these materials are first dissolved or dispersed into a slurry by a prior waste storage or preparation step. The waste may be saturated with dissolved salts and may be at or above ambient temperature.

4.4.1.4 Waste Location. The waste of concern for waste transfers is located in one or more bulk layers in a DST. The waste at the surface is not distinguished from the bulk subsurface layers for transfer-related functions.

4.4.1.5 Tank Condition. Samples may be obtained during mixer pump operation for those transfers that are to be conducted under mixing conditions, to evaluate the extent to which the solids are suspended in the slurry. Additional supernate and solid samples may be obtained after mixer pump shutdown to evaluate the settling behavior and unsuspended solid heel. Samples obtained after mixer pump shutdown may not capture fast-settling solids, which may prove to be problematical during waste transfers.

4.4.2 Dissolve Soluble Waste in East Area Double-Shell Tanks

The Dissolve Soluble Waste in East Area DSTs function in HNF-5136 contains a Sample Prepared LAW subsidiary function. The sampling function provides process control information to monitor the progress of the dissolution activity and determine when the prepared waste is ready to be transferred to an LAW staging tank or to another DST. HNF-5136 identifies the Sample Prepared LAW function to obtain pretransfer samples before the waste is transferred, to obtain data to support a compatibility assessment, and to evaluate transfer-related parameters and establish dilution ratios.

4.4.2.1 Process Control Sampling. Process control samples may be obtained to monitor the progress of the waste dissolution activity. Flowsheets have been developed for a number of LAW tanks. However, process control strategies, process control plans, and DQOs are not yet available to identify specific process control sampling requirements.

4.4.2.1.1 Type of Data. The composition of the supernate, supernate solids content, and solids settling behavior may be required to track the progress of the waste dissolution activity. Many of the constituents of interest require laboratory analysis. Samples of the undissolved suspended solids and solid heels may be obtained if needed to understand the dissolution behavior and make adjustments.

Dissolution of soluble salts may release considerable quantities of gases and vapors into the tank headspace and ventilation system. Vapor samples may be required to comply with flammable gas and regulatory requirements.

Limited real-time data may supplement sampling data or even replace some of the sampling requirements. For example, real-time measurements of gases such as hydrogen and ammonia by the DST Monitor and Control Subsystem may be far more timely and useful than sample data for controlling the dissolution process to comply with flammable gas limits. However, confirmatory sampling may be required to characterize minor species and comply with regulatory requirements. Density instruments may provide a rough indication of the amount of dissolved

salts in the supernate. Video observations and sludge weight measurements may provide indications of the extent of solids dissolution. Temperature measurements may provide an indication of the boundary between convective, mobile waste layers, and salt layers that have not yet been dissolved. Additional instrumentation may become available to monitor the supernate suspended solids content and settling behavior.

4.4.2.1.2 Waste Characteristics. Waste sampled in support of the Dissolve Soluble Waste in East Area DSTs function may be liquids, flowable slurries, settled solids, salt cakes, sludges, and gaseous contents of the DSTs. The waste may be at or above ambient temperature.

4.4.2.1.3 Waste Location. Samples may be obtained from liquids, flowable slurries, settled solids, salt cakes, sludges, and gaseous contents of the DSTs. No driver for special surface sampling is anticipated.

4.4.2.1.4 Tank Conditions. Because a goal of the LAW dissolution function is to minimize carryover of undissolved solids, it may be acceptable to sample LAW source tanks after shutting down the mixer pumps.

4.4.2.1.5 Sample Transport and Handling. Process control samples will be transported to 222-S or another designated laboratory for analysis. Temperature control during sample handling and transport should be considered when the tank temperature is above ambient and if the waste is expected to contain significant quantities of dissolved salts. Solids formed by crystallization during handling and transport cannot be distinguished from solids that were originally present in the tank when the sample was obtained. Ambient temperature sample handling and transport under these conditions may lead to incorrect conclusions about the quantity and characteristics of solids actually present in the tank waste. Sample temperature controls may not be required when the tank being sampled is near ambient temperature or when the supernate is sufficiently dilute that crystallization of dissolved salts is not anticipated. However, it should be noted that the need for temperature controlled sampling and transport has not been established. See Appendix A for further discussion of this uncertainty.

4.4.2.2 Pretransfer Sampling. Sampling will be performed before the prepared LAW is transferred to LAW staging tanks or other DSTs. Flowsheets, process control strategies, process control plans, and DQOs are not yet in place to define the type of sampling required before prepared LAW transfers.

4.4.2.2.1 Type of Data. The Compatibility DQO, HNF-SD-WM-DQO-001, identifies data required for compatibility assessments. Data for many constituents required by the Compatibility DQO cannot be readily obtained by in situ instrumentation. Therefore, samples must be transported to a laboratory for analysis. Additional data may be required for transfer-related parameters such as rheology and solids formation upon cooling, to establish dilution ratios that prevent plugging of the transfer lines. If dilution ratios are conservatively specified, and if the waste has been adequately characterized by samples obtained during the Store Waste in East Area DSTs function or by process control samples, little or no additional sampling may be required. An effort is currently under way to establish such dilution ratios using data from samples obtained by the Tank Waste Sampling System per the Tank T LAW DQO, HNF-1796.

If provided, in situ instrumentation may supplement or replace pretransfer sample data for many transfer-related parameters. Density measurements provide a rough estimate of the amount of dissolved solids. In situ suspended solids instruments may provide an indication of the liquid-solids interface to determine starting and ending liquid levels for decantation transfers.

4.4.2.2.2 Waste Characteristics. Pretransfer samples will be obtained from liquids or flowable slurries.

4.4.2.2.3 Waste Location. Pretransfer samples will be obtained from bulk liquid layers in the tank. Samples may be obtained from several levels in the tank to determine the solids/liquid interface location, to establish the starting and ending liquid levels for decantation transfers.

4.4.2.2.4 Tank Conditions. The LAW generally will be transferred after the solids have settled following mixer pump operation. Therefore, samples may be obtained when the tank is not undergoing mixing.

4.4.2.2.5 Sample Transport and Handling. Pre-transport samples will be transported to 222-S or another designated laboratory for analysis. Temperature control during sample handling and transport should be considered when the tank temperature is above ambient and if the waste is expected to contain significant quantities of dissolved salts. Solids formed by crystallization during handling and transport cannot be distinguished from solids that were originally present in the tank when the sample was obtained. Ambient temperature sample handling and transport under these conditions may lead to incorrect conclusions about the quantity and characteristics of solids actually present in the tank waste and may lead to the specification of overly conservative dilution ratios. Conversely, if many of the solids have already precipitated from a supernate sample during handling, nonconservative conclusions may be drawn about the tendency of the remaining liquid phase to form solids upon cooling. Sample temperature controls may not be required when the tank being sampled is near ambient temperature, when the supernate is sufficiently dilute that crystallization of dissolved salts is not anticipated, or when the cooling behavior is understood from previous studies. However, it should be noted that the need for temperature controlled sampling and handling has not been established, as described in Appendix A.

4.5 PREPARE LOW-ACTIVITY WASTE IN LOW-ACTIVITY WASTE STAGING TANK

From a sampling standpoint, the Prepare LAW in LAW Staging Tank function is largely similar to the Dissolve Soluble Solids in East Area DSTs function described in Section 4.4 except for waste certification sampling. The following discussion is limited to functions that differ from those described in Section 4.4.

4.5.1 Type of Data

Laboratory analyses are required to certify the quantity and composition of LAW staged in LAW staging tanks before it is transferred to the vitrification facility. While DQOs have not been

developed yet, the required data are documented in BNFL-5193-ID-19, *Interface Control Document Between DOE and BNFL Inc. for Low-Activity Waste Feed*, ICD-19. In addition to samples submitted for analysis at the RPP-designated laboratory, samples also will be delivered to the Privatization Contractor for testing and analysis. Sampling protocols to ensure that the samples are representative of the waste to be delivered are still being negotiated.

4.5.2 Waste Characteristics

The waste to be sampled consists of liquids and/or readily pumpable slurries with low solids loadings. ICD 19 requires the LAW to contain less than 2% by weight of insoluble solids.

4.5.3 Waste Location

The waste to be sampled consists of the bulk layers to be transferred to the Privatization Contractor. In addition, ICD-19 requires that the waste contain no separate organic layer. Because tributyl phosphate, normal paraffin hydrocarbon, and other solvents used during fuel reprocessing at the Hanford Site are less dense than water, this requirement may drive a need for examining the LAW waste surface for the presence of a floating organic layer.

4.5.4 Tank Conditions

The low solids loadings specified in ICD-19 will be achieved by allowing any suspended solids to settle before they are transferred to the Privatization Contractor. Consequently, LAW certification samples will be obtained when the tank is not undergoing mixing.

LAU tanks containing less than 2% by weight of insoluble solids may be mixed prior to transfer, to reduce the amount of solids remaining in the tank. In such cases, sampling during tank mixing may be considered, to assume representative sampling.

4.5.5 Sample Transport and Handling

Waste staged for delivery to the Privatization Contractor are expected to be sufficiently dilute that ambient temperature sample handling and transport can be employed. Samples must be transported to the Privatization Contractor's designated facility as well as to the RPP contractor's designated laboratory. However, further study is required to determine the need for temperature controlled sampling and handling, as described in Appendix A.

4.6 PREPARE HIGH-LEVEL WASTE SLUDGES IN HIGH-LEVEL WASTE STAGING TANKS

From a sampling standpoint, the Prepare HLW Sludges in HLW Staging Tanks function defined in HNF-5136 is largely similar to the Mobilize and Suspend Insoluble Waste Within East Area DSTs function described in Section 4.4.1, except for waste certification sampling. Only those functions that differ from those described in Section 4.4.1 are described here.

4.6.1 Type of Data

Laboratory analyses are required to certify the quantity and composition of HLW staged in HLW staging tanks before it is transferred to the vitrification facility. While DQOs have not yet been developed, the required data are documented in BNFL-5193-ID-20, interface Control Document between DOE and BNFL for High-Level Waste Feed, ICD-20. In addition to samples submitted for analysis at the RPP-designated laboratory, samples will also be delivered to the vitrification contractor for testing and analysis. Sampling protocols to ensure that the samples are representative of the waste to be delivered are still being negotiated.

4.6.2 Waste Characteristics

The waste to be sampled consists of flowable slurries. Solids are suspended in the supernate phase by operating mixer pumps.

4.6.3 Waste Location

The waste to be sampled consist of the bulk layers to be transferred to the vitrification contractor. In addition, BNFL-5193-ID-20, *Interface Control Document Between DOE and BNFL Inc. for High-Level Waste Feed*, ICD 20, requires that the waste contain no separate organic layer. Because tributyl phosphate, normal paraffin hydrocarbon, and other solvents used during fuel reprocessing at the Hanford Site are less dense than water, this requirement may drive a need for examining the HLW waste surface for the presence of a floating organic layer. However, it should be noted that extensive past efforts to eliminate these organics makes it unlikely that they will be encountered.

4.6.4 Tank Conditions

For the waste certification samples to be representative of the slurry to be delivered to the Privatization Contractor, samples may be obtained during mixer pump operation. If, however, settling rate data are available to indicate that little bias would result from sampling immediately after mixer pump shutdown, that approach may be viable as well. If sampling is required to confirm the absence of a separable organic layer, it may be necessary to obtain such surface samples after the mixer pumps have been shut down long enough for any separable organics to coalesce and form a separate layer. It should be noted that the need for sampling during mixer run operations is questionable, as discussed in Appendix A.

4.6.5 Sample Transport and Handling

Waste staged for delivery to the Privatization Contractor are expected to be sufficiently dilute that ambient temperature sample handling and transport can be employed. Samples must be transported to the Privatization Contractor's designated facility as well as to the RPP contractor's designated laboratory. Further study is required to determine the need for temperature controlled sampling and handling, as discussed in Appendix A.

5.0 DOUBLE-SHELL TANK PROCESS WASTE SAMPLING SUBSYSTEM DESCRIPTION

The PWSS consists of hardware that removes waste samples from DSTs for observation, testing, and or analysis in support of the WFD mission. These samples include both HLW (solid and liquid) and LAW (liquid only). In most cases, the PWSS captures samples of DST contents in sample containers, and transports the filled sample containers to a laboratory for analysis. In some cases, observations or measurements may be performed in the field. Various sample collection and handling architectures are employed to accommodate different waste characteristics, locations within DSTs, measurement criteria, and operating conditions. The purpose of sampling is to obtain specific information about waste characteristics that is needed to make informed decisions about the storage and processing of the waste. Consequently, the type, quantity, and timing of samples obtained are driven by data requirements and constrained by waste characteristics and process conditions. The data requirements, and hence the functions and architectures required to support those needs, continue to evolve as process control strategies and flowsheets are developed in parallel with the development of the PWSS specification.

To accomplish the functions described in Section 4.0, the PWSS is decomposed into seven different sample collection subsystems and two sample handling and transport subsystems, as shown in Figure 5-1. Four of the sample collection and one of the sample handling subsystems may coincide with subsystems of the Tank Waste Sampling System and require minimal further development. The performance requirements, and even the need for, the remaining subsystem architectures cannot be fully defined until performance requirements are clearly established during the specification development effort. (See Appendix A).

Figure 5-1. Double-Shell Tank Process Waste Sampling
System Architecture Decomposition.

The seven types of sample collection architectures shown in Figure 5-1 are described below.

- The core sampling subsystem at a minimum captures solids, sludges, and highly viscous slurries, and may also capture liquids and gases. Existing Tank Waste Sampling System core sampling subsystems currently perform this function. Specialized self-contained core sampling trucks insert a drill string containing sample containers into the waste and retrieve the samples for shipment to the laboratory. The drill string may be inserted into the waste by pushing a sharpened sample bit directly into the waste or by drilling action with cutting bits at the end of the drill string. The sampling devices incorporate a variety of seals and closures that can retain liquids and gases within the sampler. To comply with the applicable safety and performance requirements, the core sampling trucks have evolved into complex, specialized, and maintenance-intensive systems. Safety features prevent drilling through the tank shell or igniting flammable gases in the tank. The core sampling drill string cannot withstand the jet impingement forces produced by a mixer pump and consequently can only sample tanks not undergoing mixing.
- The grab sampling subsystem captures liquids and low-viscosity slurries in sample bottles lowered directly into the waste. Existing Tank Waste Sampling System architectures currently perform this function. Grab samples taken from lower tank waste elevations can be contaminated with waste from upper levels because the basic gas sampler is not closed. Specialized hoists and holding fixtures lower closed bottles to precise elevations in the tank, then release the closures to admit tank waste for filling. The grab sampling subsystem cannot withstand the jet impingement forces produced by a mixer pump and consequently can only sample tanks not undergoing mixing.
- The vapor sampling subsystem captures gases and vapors in the tank headspace. A variety of canisters and sorbents are employed depending on the chemical or radiological component of interest, required detection limits, and other considerations. Existing Tank Waste Sampling System vapor sampling subsystem currently perform this function.
- The agitated tank grab sampling subsystem captures liquids and low-viscosity slurries in sample bottles lowered directly into the waste. Existing sampling systems are not available to perform this function. Specialized hoists and holding fixtures lower closed bottles to precise elevations in the tank, then release the closures to admit tank waste for filling. Robust mechanical guides allow the agitated tank grab sampling system to withstand the jet impingement forces produced by a mixer pump and consequently allow the sampling of tanks undergoing mixing.
- The pumped sampling and analysis loop subsystem circulates tank waste through an above-ground sample container filling station and measurement devices. Existing sampling systems are not available to perform this function. The variable-depth fluidic sampler and at-tank analysis system described in *Level 2 Specification for the Nested, Fixed-Depth Sampling and the At-Tank Analysis System*, HNF-3483, if deployed, will perform this function. Real-time information can be obtained for a limited set of key parameters to evaluate mixing behavior, waste uniformity, and transfer-related properties for which timeliness is important. By adjusting the sample intake elevation, a

representative composite sample of the as-suspended tank contents can be prepared. Robust mechanical guides allow the pumped sample/analysis loop to withstand mixer pump jet impingement forces. Tanks can be sampled when undergoing mixing.

- The liquid surface sampling subsystem obtains samples from the surface of tanks containing a liquid waste surface to confirm the absence of a “visible floating organic layer” as defined in the Privatization Contract. Existing sampling systems are not available to perform this function. Grab and core samples have been employed to characterize liquid waste surface layers in the past, but neither technique is well suited to capture a thin floating organic layer.
- The solid surface sampling subsystem captures solids from the uppermost layer of a tank containing a solid waste surface. Architectures to perform this function are provided by the auger and finger sampling subsystems of the Tank Waste Sampling System.

The two types of sample handling and transport architectures are described as follows.

- The ambient temperature sample handling and transport subsystem retrieves, seals, overpacks, stores, transports, and delivers sample containers to designated laboratories. Existing Tank Waste Sampling System architectures are in place to perform this function.
- The controlled temperature sample handling and transport subsystem maintains the sample container at a constant temperature matching that of the tank waste layer from which the sample was obtained from the time that the sample is retrieved from the tank until custody of the sample is transferred to the designated laboratory. Existing sampling systems are not available to perform this function. It is anticipated that new storage structures, trucks, and other handling equipment will be required. New storage and handling architectures also will be required at the designated laboratory or laboratories to receive and process the temperature-controlled samples. It should be noted that the need for temperature controlled samples has not been established, as discussed in Appendix A.

As was described in the functional analysis in Section 5.0, the ambient temperature sample handling and transport subsystem handles the sample containers filled by seven sample collection architectures. The controlled temperature sample handling and transport subsystem is only required to handle core, grab, agitated tank grab, and pumped loop samples. Vapor, solid-surface, and liquid-surface samples will not require temperature controlled handling, transport, and processing.

Flowsheets are being developed to establish the temperatures, compositions, phases, and other characteristics of the waste at each step of the WFD process for each HLW and LAW tank. Process flowsheets already have been developed for one HLW source tank (241-AZ-101) and three LAW source tanks (241-AN-104, 241-AN-105, and 241-AN-107), HNF-1939. Process control strategies and process control plans, when developed, will establish the type, quality, and timeliness of data required to implement these flowsheets and control the process. Information from these documents will be required to fully define which subsystems will be used at each step of the WFD process. Figure 5-2 illustrates the logic to select the appropriate subsystem of the PWSS according to waste characteristics, location, data type, and operating conditions. However, if a subsystem indicated in Figure 5-2 is being deployed on a tank for other reasons, then that

subsystem will produce an acceptable sample as well, and some duplication may be eliminated. For example, the solid surface sampling system is the quickest and most cost-effective way to sample a solid crust. However, if the core sampling subsystem is being deployed at that tank to sample the solid heel at the bottom of the tank, then the core sampling subsystem can perform the solid surface sample function as well, eliminating the need for deploying the solid surface sampling subsystem. A similar situation exists with respect to the agitated tank grab sampling subsystem and the costlier, more complex pumped sampling and analysis loop subsystem. In cases where the pumped sampling and analysis loop subsystem must be deployed to obtain limited real-time data, there is no need for an additional deployment of the agitated tank grab sampling subsystem.

It should also be noted that rising availability and surface space on DSTs will have a significant impact on the ability to deploy some sampling systems. Selected architectures must be compatible with other mixer and measuring equipment that will be inserted into the tank through risers. This and other considerations must be included in selecting the sampling subsystems to be used by the PWSS.

Figure 5-2. Double-Shell Tank Process Waste Sampling Subsystem Selection Logic.

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6.0 DOUBLE-SHELL TANK PROCESS WASTE SAMPLING SUBSYSTEM DEFINITION

The PWSS consists of architectures employed to collect samples of DST contents and deliver the samples to the 222-S Laboratory in support of the WFD mission. These samples include HLW, which is in both liquid and/or solid form, and LAW, which is liquid only. Solids are considered as contaminants in LAW. The Tank Waste Sampling System currently collects, handles, and transports many of the same types of samples that will be obtained by the PWSS. Such synergies will be exploited to the maximum extent practicable consistent with sampling demands for WFD DSTs and non-WFD tanks, to avoid unnecessary duplication. The PWSS provides new architectures as shown in Figure 5-1 to provide capabilities not currently available. The extent to which these new architectures are required by the WFD mission cannot be fully defined until flowsheets, process control strategies, functional analyses, and performance analyses have been developed, and BNFL Inc. waste acceptance criteria have been fully developed.

Tank wastes have been sampled and analyzed since the initial utilization of the waste tanks. The existing Tank Waste Sampling System evolved over the years in response to changing characterization data needs, technological advances, and heightened safety awareness. In response to Defense Nuclear Facilities Safety Board (DNFSB) *Recommendation 93-5*, DOE/RL 94-0001, the Tank Waste Sampling System has been upgraded and incorporated into a vigorous Characterization Program, which has resolved many of the safety concerns with respect to the tank waste. Candidate HLW and LAW source tanks are being characterized in accordance with the Tank T, HNF-1558 and HNF-1796, DQOs. The data currently being obtained may provide flowsheet information to establish dilution ratios and other parameters that would otherwise need to be measured by the PWSS during actual WFD operations. The extent to which these source tank data can be used for process control during future operations is being evaluated. Specification of conservative dilution ratios based on ongoing characterization and testing programs may reduce the sampling and analysis requirements during WFD operations.

The PWSS will consist of portable sampling devices and handling systems. For core and grab samples of tanks not undergoing mixing, the PWSS may resemble or even coincide with the existing Tank Waste Sampling System. The architectures to implement agitated tank grab sampling, temperature controlled sampling, and specialized organic layer sampling systems do not exist at this time. The need to provide one or more of these architectures will be evaluated during the performance analysis phase of the PWSS specification development process. The system cannot be fully defined until the process control strategy, flowsheets, functional analyses, performance analyses, and BNFL Inc. waste acceptance criteria have been fully developed. If instrumentation is available to measure those parameters that may otherwise require sampling of tanks undergoing mixing, temperature controlled samples, and organic layer samples, the scope of the PWSS may be limited to mere enhancements of present Tank Waste Sampling System capabilities.

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APPENDIX A

CRITICAL ISSUES

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APPENDIX A

CRITICAL ISSUES

A number of critical issues must be resolved to fully define the Double-Shell Tank (DST) Process Waste Sampling System (PWSS). These will be resolved during the development of the specifications, and may require further engineering studies.

Process development testing has not been completed for high-level waste (HLW) and low-activity waste (LAW) source tanks and blended feed batches. The most critical unknown parameter potentially affecting the PWSS is the settling rate of HLW solids. It is currently assumed in the interface control documents for waste certification that the HLW solids settle slowly enough that the waste slurry will not have changed significantly by the time the mixer pump has been shut off and grab samples are obtained. However, if future settling rate data indicate that a significant fraction of solids settles too quickly to be adequately characterized several hours after mixer pump shutdown, then mixed tank samples may be required.

Flowsheets remain to be developed for many portions of the Waste Feed Delivery mission. These flowsheets may define sample data requirements that could affect the functions and architecture of the PWSS.

Instrumentation to monitor the spatial distribution of solids during mixing and transfers has not been demonstrated under in-tank conditions. Additional information will be developed during the upcoming Tank 241-AZ-101 mixer pump test. The availability of in-tank real-time monitoring would lessen the reliance on the PWSS for solids distribution data.

Temperature control during sample handling and transport should be considered when the tank temperature is above ambient and if the waste is expected to contain significant quantities of dissolved salts. Solids formed by crystallization during handling and transport cannot be distinguished from solids that were originally present in the tank when the sample was obtained. Ambient temperature sample handling and transport under these conditions may lead to incorrect conclusions about the quantity and characteristics of solids actually present in the tank waste and may lead to the specification of overly conservative dilution ratios. Conversely, if many of the solids have already precipitated from a supernate sample during handling, nonconservative conclusions may be drawn about the tendency of the remaining liquid phase to form solids upon cooling. Sample temperature controls may not be required when the tank being sampled is near ambient temperature, when the supernate is sufficiently dilute that crystallization of dissolved salts is not anticipated, or when the cooling behavior is understood from previous studies.

A measurement protocol for detecting the presence of separable organics in staged HLW and LAW has not been established. The need for, and performance requirements for, a liquid surface sampling subsystem cannot be established until quantitative measurement requirements are established.

The process control strategy has not been finalized. When finalized, the process control strategy may define additional sampling requirements. The need for temperature controlled samples and *mixed tank samples cannot be ruled out until the process control strategy has been finalized.*

Plans for the sequencing of retrieval activities continue to undergo revision. Current planning has advanced considerably beyond the baseline planning case. This may affect the timing and type of samples required to support the mission and may affect the functions and architecture of the PWSS. Depending on the timing of sampling events, multiple systems may be required.

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