FEB 0 8 1999

Station 37

(21) **ENGINEERING DATA TRANSMITTAL**

1. EDT 622092

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Characterization Engineering	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: Characterization	6. Design Authority/ Design Agent/Cog. Eng.: FR Reich	7. Purchase Order No.: NA
8. Originator Remarks: For approval		9. Equip./Component No.: NA
		10. System/Bldg./Facility: 200G
11. Receiver Remarks: 11A. Design Baseline Document? [] Yes [X] No		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: NA
		14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Desig-nator	(G) Reason for Trans-mittal	(H) Origi-nator Dispo-sition	(I) Receiv-er Dispo-sition
1	HNF-3483	All	0	Preliminary Level 2 Specification for the Nested, Fixed-Depth Fluidic Sampler	SQ	1	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval	4. Review	1. Approved	4. Reviewed no/comment
	2. Release	5. Post-Review	2. Approved w/comment	5. Reviewed w/comment
	3. Information	6. Dist. (Receipt Acknow. Required)	3. Disapproved w/comment	6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
1	1	Char. Proj. Mgr. RM Boger [signature] 2/4/99 S7-12	1		Project Mgr. KA Gasper [signature] 2/8/99 A3-03 ~~H6-37~~
1	1	Design Authority GP Janicek [signature] 1/13/99 S7-12	1	1	Quality Assurance D.C. Board [signature] 1-13-99 S7-07
1	1	Cog Eng. RG Brown [signature] S7-12	1	1	Operations WJ Kennedy [signature] 1-18-99 S7-03
1	1	Cog Mgr. JS Schofield [signature] 1/20/99 S7-12	1	1	Safety J.A. Ranschau [signature] 1-15-99 S7-07
1	1	Char. Project JL Smalley [signature] 1/28/99 S7-12	1		Manager J.D. Criddle [signature] 1/28/99 S7-12

18.	19.	20.	21. DOE APPROVAL (if required)
[signature] 2/8/99 FR Reich Signature of EDT Originator Date	K.A. Gasper [signature] 2/8/99 Authorized Representative Date for Receiving Organization	G.P Janicek [signature] 2/8/99 Design Authority/ Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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INSTRUCTIONS FOR COMPLETION OF THE ENGINEERING DATA TRANSMITTAL

(USE BLACK INK OR TYPE)

BLOCK	TITLE	
(1)*	EDT	● Pre-assigned EDT number.
(2)	To: (Receiving Organization)	● Enter the individual's name, title of the organization, or entity (e.g., Distribution) that the EDT is being transmitted to.
(3)	From: (Originating Organization)	● Enter the title of the organization originating and transmitting the EDT.
(4)	Related EDT No.	● Enter EDT numbers which relate to the data being transmitted.
(5)*	Proj./Prog./Dept./Div.	● Enter the Project/Program/Department/Division title or Project/Program acronym or Project Number, Work Order Number or Organization Code.
(6)*	Design Authority (for Design Baseline Documents)/Cognizant Engineer (for all others)/Design Agent	● Enter the name of the individual identified as being responsible for coordinating disposition of the EDT.
(7)	Purchase Order No.	● Enter related Purchase Order (P.O.) Number, if available.
(8)*	Originator Remarks	● Enter special or additional comments concerning transmittal, or "Key" retrieval words may be entered.
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(10)	System/Bldg./Facility	● Enter applicable system, building or facility number, if appropriate.
(11)	Receiver Remarks	● Enter special or additional comments concerning transmittal.
(11A)*	Design Baseline Document	● Enter an "X" in the appropriate box. Consult with Design Authority for identification of Design Baseline Documents, if required.
(12)	Major Assm. Dwg. No.	● Enter applicable drawing number of major assembly, if appropriate.
(13)	Permit/Permit Application No.	● Enter applicable permit or permit application number, if appropriate.
(14)	Required Response Date	● Enter the date a response is required from individuals identified in Block 17 (Signature/Distribution).
(15)*	Data Transmitted	
	(A)* Item Number	● Enter sequential number, beginning with 1, of the information listed on EDT.
	(B)* Document/Drawing No.	● Enter the unique identification number assigned to the document or drawing being transmitted.
	(C)* Sheet No.	● Enter the sheet number of the information being transmitted. If no sheet number, leave blank.
	(D)* Rev. No.	● Enter the revision number of the information being transmitted. If no revision number, leave blank.
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	(F)* Approval Designator	● Enter the appropriate Approval Designator (Block 15). Also, indicate the appropriate approvals for each item listed, i.e., SQ, ESQ, etc.
	(G) Reason for Transmittal	● Enter the appropriate code to identify the purpose of the data transmittal (see Block 16).
	(H) Originator Disposition	● Enter the appropriate disposition code (see Block 16).
	(I) Receiver Disposition	● Enter the appropriate disposition code (see Block 16).
(16)	Key	● Number codes used in completion of Blocks 15 (G), (H), and (I), and 17 (G), (H) (Signature/Distribution).
(17)	Signature/Distribution	
	(G) Reason	● Enter the code of the reason for transmittal (Block 16).
	(H) Disposition	● Enter the code for the disposition (Block 16).
	(J) Name	● Enter the signature of the individual completing the Disposition 17 (H) and the Transmittal.
	(K)* Signature	● Obtain appropriate signature(s).
	(L)* Date	● Enter date signature is obtained.
	(M)* MSIN	● Enter MSIN. Note: If Distribution Sheet is used, show entire distribution (including that indicated on Page 1 of the EDT) on the Distribution Sheet.
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(19)	Authorized Representative for Receiving Organization	● Enter the signature and date of the individual identified by the Receiving Organization Design Authority (for Design Baseline Documents)/Cognizant Engineer (for all others) as authorized to approve disposition of the EDT and acceptance of the data transmitted, as applicable.
(20)*	Design Authority/Cognizant Manager	● Enter the signature and date of the Design Authority/Cognizant Manager. (This signature is authorization for release.)
(21)*	DOE Approval	● Enter DOE approval (if required) by signature or control number that tracks the approval to a signature, and indicate DOE action.

*Asterisk denote the required minimum items check by Configuration Documentation prior to release; these are the minimum release requirements.

PRELIMINARY LEVEL 2 SPECIFICATION FOR THE NESTED, FIXED-DEPTH SAMPLING SYSTEM

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U.S. Department of Energy Contract DE-AC06-96RL13200

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Key Words: level 2 specification, functional design criteria, waste sampling, double-shell, LAW, HLW, sampling system, at-tank analysis

Abstract:
This preliminary Level 2 Component Specification establishes the performance, design, development, and test requirements for the in-tank sampling sampling system which will support the BNFL contract in the final disposal of Hanford's High Level Wastes (HLW) and Low Activity Wastes (LAW). The PHMC will provide Low Activity Wastes (LAW) tank wastes for final treatment by BNFL from double-shell feed tanks. Concerns about the inability of the baseline "grab" sampling to provide large volume samples within time constraints has led to the development of a nested, fixed-depth sampling system. This sampling system will provide large volume, representative samples without the environmental, radiation exposure, and sample volume impacts of the current base-line "grab" sampling method. This preliminary Level 2 Component Specification is not a general specification for tank sampling, but is based on a "record of decision", AGA (HNF-SD-TWR-AGA-001), the System Specification for the Double Shell Tank System (HNF-SD-WM-TRD-007), and the BNFL privatization contract.

Karen H. Noland 2/8/99
Release Approval Date

Release Stamp

FEB 08 1999
DATE:
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21

Approved for Public Release

PRELIMINARY

LEVEL 2 SPECIFICATION

FOR THE

NESTED, FIXED-DEPTH SAMPLING SYSTEM

HNF-3483

REVISION 0

Prepared for Lockheed Martin Hanford Corporation
Characterization Engineering Group

by

F. R. REICH
J. L. SMALLEY

COGEMA Engineering Corporation
Richland, Washington

February 1999

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FOR THE
NESTED, FIXED DEPTH SAMPLING SYSTEM

1.0 SCOPE

1.1 INTRODUCTION

This specification establishes the functional and performance requirements for a sampling system to support the privatization contract (Tanks Waste Remediation System Privatization Contract DE-AC06-96RL13308, Mod. No. A006, 1996, U.S. Department of Energy, Richland, Washington with BNFL, Inc.) in the final disposal of Hanford's high level wastes (HLW) and low activity wastes (LAW). This is not a general specification for tank sampling, as outlined in System Characteristic 3.2.1.5 "Sample Double Shell Tank Waste" in the *System Specification for the Double-Shell Tank System* (HNF-SD-WM-TRD-007). The justification for pursuing this sampling system is based on the "record of decision," AGA (HNF-SD-TWR-AGA-001, Rev. 1), the *System Specification for the Double-Shell Tank System* (HNF-SD-WM-TRD-007. Rev. D), and the privatization contract which modify the double shell system document characteristics (TBRs in the double-shell system document). The purpose of this document is to provide a comprehensive list of functions, requirements, and specifications to support the design, development, performance assessment, and testing of a sampling system (herein referred to as a nested, fixed-depth sampling system) that will meet the privatization contract requirements. As these design and testing activities proceed, additional criteria will be available for this document, including requirements and criteria as identified from the hazards analysis that will be completed on the design of the prototype sampling system.

1.1.1 System Overview

The sampling system will be used to extract and package samples that are representative of the waste contents of the Project Hanford Management Contract (PHMC) feed tanks that will supply envelope A, B, and C wastes for the Phase 1 B privatization contract. The samples will be packaged for shipment in the Hanford site shipping Pig transportation system ("Safesend"™ over-pack and/or Steel Pig). The Hanford tank wastes are made up of residues from nuclear weapons processing at the Hanford Site and contain hazardous, caustic chemical and radioactive materials. These materials are in liquid, slurry/sludge and solid forms, with some of the solids being made up of very abrasive materials. The sampling system shall operate over the 20- year lifetime of the privatization contract.

The sampling system must conform to all tank farm criteria for hardware deployed in

Hanford's underground waste storage tanks. This includes criteria established for equipment deployment and operation in waste tanks with flammable gas concerns, adherence to tank riser and dome load limits, quality assurance requirements, and other criteria discussed below. The objectives for the sampling system in supporting the privatization contract include the capability to:

- extract waste samples that are representative of the waste material in the PHMC Team's feed source and/or staging tanks (it is desired that these samples be representative of a tanks content within a 95% confidence interval)
- obtain representative waste samples from full and partially full tanks
- provide relatively large volumes (two to 15 liters within an eight-hour time period) of sample waste material, with minimal impact from weather conditions currently affecting the base-line, grab sampling method
- complete a large volume sample campaign within an eight-hour time period without adverse impacts from other in-tank operations, including mixer pumps, decanting operations, etc.
- be deployed in a double-shell tank (DST), meeting all tank farm requirements that include dimensional limits, riser and dome loading limits, and environmental, safety, and regulatory criteria
- operate over an anticipated 20 year time span of the privatization contract
- interface with a 500-ml sampling bottle and the current "Safesend"™ over-pack or the Steel Pig
- meet flammable gas ignition source set 1 as defined in HNF-SD-WM-TBR-006, Rev. 0, Section 5.10.2c.

One technology, capable of meeting these performance objectives, is based on fluidic principles where no moving mechanical components or electrical components are in contact with waste and no moving mechanical components are used to extract a waste sample. Figure 1 shows one potential embodiment of a conceptual sampling system, based on a discrete number of sampling channels (nested, fixed-depth sampling system) in a conceptual PHMC feed tank (AP-102 and/or AP-104 double-shell waste tanks) deployment. The sub-systems of the sampling system consist of a waste multi-port sampler, sampling module, riser interface module, control system, and utilities support module as illustrated in Figure 1. The functions and requirements for these sub-modules are described below but include a sampling module that has the means to provide a waste flow stream interface for the at-tank analysis sensor systems. The AP-102 and AP-104 tanks, the shielded shipping Pig that will be used to transport the waste samples and the electrical and compressed air utility support that interface with this system are not part of this Level 2 Specification and are support/interface systems for the sampling system. In future revisions, an at-tank analysis system Level 2 Component Specifications will be added to this document.

1.1.2 Relationship to Double-Shell Tank System and Privatization Contract

The final treatment of the HLW and LAW tank wastes will be completed through a privatization contract with BNFL. The privatization contractor, BNFL, will be responsible for waste separation/treatment and glassification, but the Hanford Site has the responsibility of supplying waste feed materials in a suitable condition and within a scheduled time interval to support the privatization contract. Prior to transfer to the privatization contractor, the waste feed in the PHMC team staging tanks must be shown to conform to the TWRS privatization contract waste feed envelopes A, B, or C specifications. To assure that these waste conditions are met, the contents of the PHMC staging tank will be sampled prior to the transfer to the privatization contractor's tanks. The current baseline, approved method for sampling tank liquids is "grab" sampling, which is a "bottle on a string" technique. There are a number of issues with "grab" sampling, including a biasing of samples with materials from the upper levels of the waste in a tank. Grab sampling also requires significant operator exposure as the process is a manual-based operation that is interrupted by adverse weather conditions. The basic concern associated with this grab sampling is that the long time to assure that a tank is well mixed and to extract representative samples may conflict with the schedule needs for staging batches of waste feed.

The system addressed in this specification will provide samples for "qualification" of wastes to support the privatization contract as required in the *System Specification for the Double-Shell Tank System* document (HNF-SD-WM-TRD-007). The specific DST System characteristics that this Level 2 specification addresses include the following:

- System Characteristic 3.2.1.3 "Prepare Low-Activity Waste Feed for Phase 1 Treatment. This characteristic states: " The system shall prepare and qualify waste in the staging tanks as LAW feed and transfer it to the LAW or LAW/HLW Plant feed tanks."

  a. "Low-Activity Waste Feed Composition and Physical Properties, Phase 1": This characteristic states: "The system shall deliver independent batches of LAW feed satisfying Envelopes A, B, or C as selected by the Operator. Envelopes A, B, and C as defined in Tables 3-3 and 3-4 shall have a sodium concentration between 3M and 14M."

  d. "Low-Activity Waste Feed Frequency, Phase 1":

This characteristic states: "The system shall be capable of mobilizing, staging, blending, qualifying, and delivering a batch of LAW feed to the vender every 182 days from sources where soluble salts must be dissolved and every 125 days (TBR) from sources consisting of supernatant."

- System Characteristic 3.2.1.3.1, "Blend Low-Activity Waste in Low-Activity Waste Staging Tanks"
  This characteristic states: "The system shall blend, pretreat, and qualify waste in the LAW staging tanks."

  a. "Low-Activity Waste Staging Batch Size, Phase 1":
  This characteristic states: "The system shall be capable of blending and qualifying batches of LAW feed with a volume of 1,040 m^3 (0.3 Mgal)(TBR) to 4,400 m^3 (1.16 Mgal). The system shall blend and qualify each batch of LAW feed in less than or equal to 113 days (TBR).

Future sampling systems will also provide privatization contract support in the qualification and facility delivery schedules for HLW waste from the *Double-Shell System* (HNF-SD-WM-TRD-007):

- System Characteristic 3.2.1.4, "Prepare High-Level Waste Feed For Phase 1 Treatment."
  This characteristic states: "The system shall prepare and qualify waste as HLW feed and transfer it to the LAW/HLW plant. Blend Low-Activity Waste in Low-Activity Waste Staging Tanks"

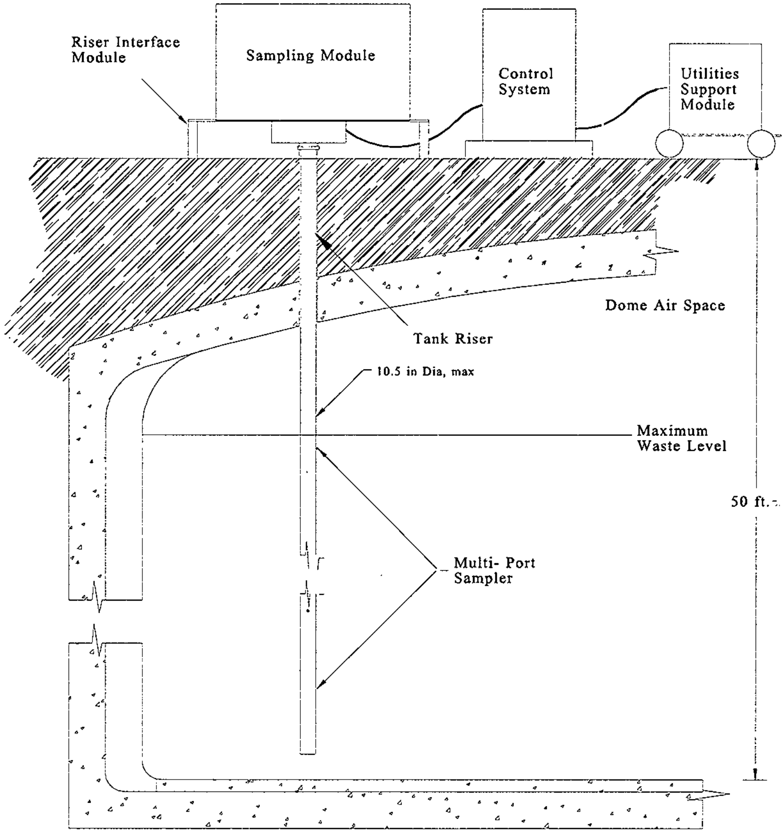

Figure 1. Nested, Fixed-Depth Sampling System Deployed in a Double-Shell Waste Tank

2.0 APPLICABLE DOCUMENTS

The requirements applicable to the sampling system come from both government and non-government source documents. These documents define requirements for the system's design, its products and effluents, and interfaces. The requirements in these documents support the successful completion of the TWRS mission and DST. Each document identified in this section is representative of a part of this Level 2 Component Specification.

2.1 U.S. GOVERNMENT DOCUMENTS

DOE orders and regulatory documents, including those from the federal and Washington state government, are the basis for parts of this specification. Documents that form a part of this specification are listed below:

2.1.1 Federal Documents

2.1.1.1 Code of Federal Regulations

10 CFR 830 Nuclear Safety Management

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1926 Safety and Health Regulations for Construction

40 CFR 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.

47 CFR 15 Federal Communication Commission Rules and Regulations

- Subpart B, Emergency Management Center Regulations

2.1.1.2 U.S. Department of Energy Orders

DOE 6430.1A General Design Criteria

2.1.1.3 Other U.S. Department of Energy Documents

Project Hanford Management Contract - LMHC Subcontract No. 80232764-9-K-001 Occupational Safety and Health, Fire Protection; and Nuclear Safety section of the DOE-approved TWRS-SRID (WHC-SD-MP-SRID-001)

Integrated Environment, Safety and Health Management System (ISMS) Plan (HNF-MP-003).

Project Hanford Policies and Procedures located on the Hanford Intranet and in TWRS-specific procedures contained in HNF-IP-0842, TWRS Administration.

Health and Safety Plan (HASP) (HNF-SD-WM-HSP-002) - health and safety requirements for the individual tank farms.

2.1.1.4 Other Government Documents

NUREG 0700,	Section 6.6.
MIL-STD-1472C,	Section 5.5.

2.2 STATE DOCUMENTS

WAC 173-303	Dangerous Waste Regulations
WAC 173-360	Underground Storage Tank Regulations

2.3 NON-GOVERNMENT DOCUMENTS

ASME Y14.5M	Dimensioning and Tolerancing
ASME B31.3	Chemical Plant and Petroleum Refinery Piping
ASME B&PV	ASME Boiler and Pressure Vessel Code Section IX
AWS D1.1	Structural Welding Code - Steel
AWS D1.3	Structural Welding Code - Sheet Steel
NEMA	National Electrical Manufacturers Association
NFPA 70	National Fire Protection Association, National Electric Code

2.4 HANFORD SITE PROCEDURES

The Hanford Site documents listed below form a basis for part of this specification to the extent specified herein. The HNF-PROs implement federal and state regulations and DOE orders. Prior to their use, it is the responsibility of the user to verify these HNF-PROs remain compliant with the latest revision of their parent regulations and with the DOE orders imposed by contract.

HNF-PRO-154	Responsibilities and Procedures for all Hazardous Materials
HNF-PRO-157	Radioactive Materials/Waste Shipments
HNF-PRO-241	Engineering Specification Requirements
HNF-PRO-242	Engineering Drawing Requirements
HNF-PRO-243	Interface Control Requirements
HNF-PRO-268	Control of Purchased Items and Services
HNF-PRO-444	Vendor Information
HNF-PRO-445	Design Verification Requirements
HNF-PRO-446	Testing Requirements
HNF-PRO-451	Regulated Substance
HNF-PRO-702	Safety Analysis Process - Facility Change or Modification
HNF-PRO-703	Safety Analysis Process - New Project

2.4.1 Other Hanford Site Documents

HNF-SD-WM-BIO-001	Tank Waste Remediation System Basis for Interim Operation
HNF-SD-WM-HSP-002	Tank Farm Health and Safety Plan

HNF-SD-WM-TSR-006	Tank Waste Remediation System Technical Safety Requirements
WHC-SD-TP-SARP-001	Sample Pig Transport System Safety Analysis Report for Packaging (onsite).
HSRMC-1	Hanford Site Radiological Control Manual.

3.0 SAMPLING SYSTEM FUNCTIONS AND REQUIREMENTS

3.1 SAMPLING SYSTEM/COMPONENT DEFINITION

The sampling system shall provide waste samples from the PHMC's double-shell (DST) feed tanks (AP-102 and/or AP-104) that are representative of the feed tank waste contents. The sampling system shall be used to extract and package waste samples for shipping with the Hanford's site Pig transportation (Safesend over-pack and/or Steel Pig) systems. In order to meet the system objectives above, the sampling system shall be based on fluidic principles where no moving mechanical components are used to "pump" or extract waste from the waste tank.

3.1.1 Subsystem/Component Descriptions

The sampling system shall consist of a multi-port sampler, sampling module, riser interface module, control system, and utilities support module as indicated in Figure 1.

3.1.1.1 Multi-Port Sampler

The multi-port sampler shall pump waste samples from a minimum of eight elevations, ranging from a minimum of 1 ft to a maximum of 33 ft in the PHMC feed tank, into a sampling station where 500-ml sample containers can be filled and packaged for transportation with the Hanford site, Pig transportation system. The sampling channels in the multi-port sampler extend up through the tank riser and into the sampling station. The maximum "lift" distance (defined as the distance between a sample channel inlet and the highest elevation of the waste in the sampling station) for AP-102 is approximately 57 ft. Therefore, the multi-port sampler must be capable of "lifting" a sample at least 57 ft. Waste pumping from each sampling position in the tank may be intermittent or continuous, but shall be of such a capacity (volume rate of flow and flow duration) to enable a 500-ml sample bottle to be filled completely during a single discrete flow duration (pumping cycle) if so desired or otherwise required by sample bottle filling methodology. The multi-port sampler shall be designed as a monolithic structure that is physically supported within the feed tank by the riser interface module. The housing of the multi-port sampler shall be a continuous, sealed pipe-like structure that prevents waste from contacting the outer surfaces of the sampling channels and provides support and mounting features for the sampling channels. Each sampling channel of the multi-port sampler shall have a thermocouple junction located at its inlet to sense the temperature of the tank waste at that waste level. The waste materials from each sampling channel shall flow up through the riser interface module and into the sampling module. The multi-port sampling module shall use a single, common drive/control system, located above grade, and valve manifolds for connecting to its sampling channels. The valve manifolds shall be located in the sampling module. The multi-port sampler shall include the capabilities for water flushing of all internal surfaces of the piping that contact the tank waste and water flushing for unplugging a waste-plugged sampling channel. The system to implement this water flushing will be located above grade in the sampling module and/or the riser interface module and connected to the control and utilities support modules. The multi-port sampler structure shall include radiation shielding to reduce the radiation "shine" being emitted from the tank riser (see section 3.2.2.3 below). The multi-port sampler shall be constructed of material that meets flammable gas ignition source control set 1 criteria (Section 5.10.2c, HNF-SD-WM-TSR-006, Rev. 0).

3.1.1.2 Sampling Module

The sampling module shall be used to insert, fill, decontaminate, and pre-package sample containers for transport with the Hanford Steel Pig or the "Safesend"™ over-pack systems. The sampling module shall consist of multiple sealed compartments, including a sampling station and packaging station. Operations within the packaging station shall be manual, using shielded gloves through glove ports. Empty and filled sample containers shall be manually moved in/out of the packaging station via a sealed doorway. The packaging operations shall include bagging and inserting into an over-pack and are further defined in the Pig transportation documentation. A second sealed doorway shall connect the packaging chamber with the sampling chamber. This doorway shall be opened only when the outer doorway is closed to prevent direct waste pathways to the environment. The sampling station shall contain remote handling hardware and piping/fixtures to remotely manipulate sample containers and to fill them with waste from the multi-port sampler. Remote mechanical handling hardware shall also be used to move sample containers between the two chambers through the inner doorway. All sample container operations within the sampling station (sample container movement, decontamination, capping, and etc.) shall be completed with remote mechanical hardware that is manually operated from the outside of the sampling module. The sampling station shall also include water spray and drain capabilities to be able to decontaminate the outer surfaces of the sample container and the interior surfaces of the sampling station. The sampling station shall also contain the piping, valves, etc.

to enable this wash residue to be returned to the waste tank. The sampling station shall be designed to be operated without a sample bottle in the sampling station, with no material loss or exiting from the hardware that fills the sample bottle.

The sampling and packaging compartments shall each have viewing ports for observing operations with the sample container during the completion of all sample container operations, including decontamination with the water sprays. The viewing port in the packaging compartment shall allow complete visibility of the container and the packaging materials during the completion of the bagging and packaging operations.

The sampling module shall house the valve manifolds for the vacuum/pressure sources that drive the multi-port sampling channels and connect the sampling channels with the sampling station and the valves and controls for the multi-port water flushing system. The sampling module shall also contain space for a "spool piece" for interfacing the waste stream with the at-tank analysis system sensors/transducers. The sampling module shall also contain sensors, status indicators, and limit switches needed to assure safe operation of the sampling process and heating/cooling systems to maintain the temperatures and the tank wastes within acceptable limits.

The sampling module housing shall also include radiation shielding to reduce the radiation exposure to an operator (see Section 3.2.2.3 below). The radiation shielding shall be part of any area of the module that contains tank waste where an operator may be exposed to the radiation.

3.1.1.3 Riser Interface Module

The riser interface module shall provide the interface between the multi-port sampler, the sampling module, and the waste tank riser. The riser interface module shall support the weight of the multi-port sampler, part of the weight of the sampling module, and provide a sealed, "soft" interface with the tank riser. The riser interface module shall hold the multi-port sampler in a rigid manner so that side loads imparted to the multi-port sampler by the in-tank mixer pump are not totally transferred to the riser, but are less than the loads indicated below in Section 3.2.2.2, "Tank Riser and Dome Loading." The riser interface module shall also contain a water spray wash system, which will be used to wash and decontaminate the outer surface of the multi-port sampler when it is removed from the tank riser. It shall also contain sensors, status indicators, and limit switches to support the safe completion of the sampling process. The sampling channel water flushing system shall be part of or interface to the multi-port sampling channels through the riser interface module. The riser interface module may also house a pressurized air source and vacuum source (if produced by a jet-pump pair from a pressurized gas source) required to drive the sampling channels. The riser interface module shall contain radiation shielding on all areas that make contact with tank waste to reduce the radiation exposure to operators (see Section 3.2.2.3 below).

3.1.1.4 Control System

The control system shall provide the interface between the operator and all of the sampling system modules. The exception is the remote, mechanical handling hardware in the sampling module that will be accessed at the surface of the sampling module. The control system shall contain a panel with actuators and indicators, control logic/interlocks for operating the multi-port samplers and automated hardware in the sampling module, and the power conditioners and signal buffers for the sensors, actuators, and readout electronics. The control system shall be housed in an environmentally controlled enclosure (moisture-proof), which has cooling and heating capabilities to maintain the temperature of the control system components (especially the components that control the water flushing systems) within an acceptable operating range (40-80 F). Operation of the multi-port sampler pumping and sample bottle filling systems shall be automatic for obtaining waste samples at all required tank levels and not require any real-time intervention or control by an operator, except perhaps for initiating and terminating these operations. Manual override capability and selectivity to obtain one or more samples from a given tank level shall be incorporated in the control system design.

3.1.1.5 Utilities Support Module

The utilities support module shall provide the utility resources, (including the electrical, decontamination and flushing water, and compressed air sources) needed to safely operate the sampling system. The utilities support module shall be mounted on a skid that shall contain the utility support electrical power, compressed air, and power conditioning hardware. The electrical power source for the utility support module shall be taken from the tank farm electrical utility supply, which shall include 110 volt, 60 Hz power for light duty power needs and 440 volt, 60 Hz power for heavy duty power needs. The electrical utility module shall be housed in an environmentally controlled enclosure that contains the transformers, circuit breakers, and electrical connection bus components, with fans and cooling/heating equipment as needed to assure safe operation over the range of weather conditions that will be experienced at the Hanford site. Water for flushing and/or decontamination shall be provided from a temperature-controlled water reservoir mounted on a portable skid or truck. The utilities support module shall also contain sensors and transducers that provide status of these utilities during the operation of the nested, fixed-depth sampling system. The specific electrical power, compressed air, and flushing water requirements and the system operating parameters shall be identified from the results of proof-of-principle testing and other testing and design activities. These requirements shall be confirmed in the checkout and test of the prototype nested, fixed-depth sampling system. There is a possibility that the system may have to use nitrogen gas rather than air if waste precipitation occurs from the carbon dioxide, which is in the compressed air. The specific requirements for water and pressure/flow rate of compressed air are discussed in more detail below for a fluidic-based, nested, fixed-depth sampling system. Limits for gases exhausted to the tank are discussed in Section 3.2.1.5.4 below.

3.1.2 Interface Definition

The sampling system shall provide representative waste samples from the PHMC feed tank to support the certification of tank wastes as needed by the privatization contract. The sampling system shall sample tank waste that conforms to the waste specifications for envelopes A, B, and C as identified in the privatization contract.

3.1.2.1 Functional Interfaces

The sampling system shall interface with the DST system and shall provide representative sampling of wastes from the source tanks that include the range of constituents in the waste envelopes A, B, and C, and, in envelope D (see Appendix A). The sampling system shall support the privatization contract by providing large volumes (up to 15 liters of samples within an eight-hour time period) of waste samples that will be used to qualify LAW and HLW waste properties in the feed tank prior to transfer to the privatization contractor. The sampling system is not required to provide waste samples for general waste sampling purposes that may be required within the DST; it shall specifically support waste sampling as required by the privatization contract (HNF-SD-WM-TRD-007, Rev. D, Draft). The sampling system shall also provide a waste stream for interfacing with the at-tank analysis system. The sampling system shall include space for a "spool" piece for the at-tank analysis system waste sensors and an electronic interface for assisting the at-tank analysis system in its measurement of chemical, physical, and radioactive data from the waste stream. The control system shall be sized large enough or expandable to include space for the future at-tank analysis system control and sensor readout system.

The sampling system modules shall be designed to support ALARA (as low as reasonably achievable) by containing and controlling radioactive materials. The design of the sampling system shall facilitate "bagging-out" during decommissioning when the contaminated system modules are separated and removed from the tank installation. At a minimum, this includes adequate space to complete "tie-offs" between modules when they are physically separated, such as the separation of the sampling module from the riser interface module. The sampling system shall also contain or allow shielding to be temporarily added to protect the operators during the "bag-out" process.

3.1.2.2 Physical Interfaces

The sampling system shall be deployed in a tank riser in the PHMC feed tank located in the AP Tank Farm. The system shall specifically be interfaced with the PHMC feed tanks AP-102 and AP-104, which will be used to supply wastes to the privatization contractor. The sampling system shall make physical contact with the waste materials for envelopes A, B, C, and D, and with the tank wastes that are the sources for these envelope wastes.

3.1.2.2.1 Multi-Port Sampler Interfaces

The multi-port sampler is required to be immersed in the tank waste and in the gases within the tank dome air space. The bottom of the multi-port sampler shall not make contact with the tank bottom. The lowest sampling inlet shall sample waste at or below the 3-ft waste depth level in the waste tank. The outer containment of the multi-port sampler shall provide structural strength and shall function as a sealed thimble preventing tank waste and gases from contacting the outer surfaces of the enclosed sample channel hardware. The multi-port sampler shall be supported in the tank riser by the riser interface module. Thermocouple sensors in the multi-port sampler shall be mounted in the multi-port sampler inlets to provide the temperature measurements from the tank waste being sampled by each sampler channel. The thermocouple sensors shall connect to electronic readout modules that are part of the control system. Sampling channel piping, thermocouple wiring, etc. shall pass through the sealed interface between the multi-port sampler and the riser interface module. The riser interface module shall provide the mechanical structural support for the sampling module. The riser interface module shall rest on special ground-level concrete pads positioned around the riser. The mechanical, fluidic and any electrical connections between the multi-port sampler and the sampling module shall pass through the riser interface module. All of these penetrations shall be sealed to prevent ingress of tank dome air space gases and aerosols. The interface between the riser interface module and the tank riser shall be a sealed, "soft" interface that prevents gas exchange and transfers a minimum of the sampling system vertical and horizontal loads to the tank riser. The tank mixer pump will place horizontal loads on the multi-port sampler module from the "flow" of the tank waste from the mixer pump.

3.1.2.2.2 Sampling Module Interfaces

The sampling module shall be a sealed and radiation shielded, multi-chambered structure consisting of a sampling chamber where sample containers are filled with tank wastes and a packaging chamber where the filled sample containers are prepared for shipment with the Hanford site shipping Pig transport systems. The sampling module shall be mounted over the tank riser and shall be supported by the riser interface module (Section 3.1.1.3).

The packaging chamber of the sampling module shall be used to manually enter empty sample containers, to input and receive sample containers from the sampling station, to bag and pre-package filled sample containers for the shipping Pig transport system. These shall be manual operations, completed with use of glove ports with shielded gloves and sealed viewing ports. This chamber shall have an outer doorway to insert empty sample containers, packaging materials/containers, and removing filled sample containers. An inner doorway shall connect this chamber with the sampling chamber. This inner doorway shall be closed whenever the outer doorway on the packaging chamber is open.

The sampling chamber of the sampling module shall contain remote mechanical handling hardware to move a sample container through the inner doorway, into the sampling chamber, remote mechanical hardware to position an empty sample container on the sampling station and remove a filled sample container, and remote mechanical hardware to move a filled sample container through the inner doorway into the packaging chamber. The remote mechanical hardware shall be manually operated with externally coupled mechanical levers, cams, etc., that will be manipulated by the operator to complete the sample container handling operations. The remote sample container handling hardware shall be designed to maintain positive control of the sample container and the waste within the sample containers (the motion from the handling hardware shall be designed to prevent waste spillage and the loss of control of the container).

The piping from the multi-port sampler shall connect to valve manifolds located within the sampling module. The sampling module shall have electrical signal, electrical power, water, and vacuum/pressure interconnections from the control system as required to control the operation of the sample bottle filling system, including a minimum of two spare connections for each of these as may be required for backup or to support an alternate sampling bottle filling system. The spare connections shall be individually separated and be plumbed/wired from a point of required usage to a panel box affixed to the side of the sampling module for future interconnection to a control system. The sampling module shall be designed to meet flammable gas criteria (if inert gas is used, the gas pressures levels shall be maintained above that of the tank atmosphere) and be sealed to prevent ingress of tank atmosphere (gases and aerosols) into the sampling module. The sampling module shall also have space (a separate compartment is recommended) where the at-tank sensor spool piece will be located. This sensor spool piece shall be connected into the waste stream at a position that is downstream from the sampling station. The sampling station shall contain radiation shielding to reduce the radiation exposure to the operator (see Section 3.2.2.3 below).

3.1.2.2.3 Control System Interfaces

The control system shall have electrical signal and power connections between both the sampling module and the utilities support module. The control system shall have a control panel with actuators and indicators that will be used by the operator to safely operate the nested, fixed-depth sampling system. The control system shall be mounted on a skid and located within close proximity of the sampling module. The electrical power and other utility resources for the control system will be supplied by the utility support module.

3.1.2.2.4 Utilities Support Module Interfaces

The utilities support module shall draw its power from the from the tank farm electrical utility supply, which shall include 110 volt, 60 Hz power for light duty power needs and 440 volt, 60 Hz power for heavy duty power needs. The utilities support module shall contain the power conditioning equipment needed to all of the sampling system modules. It shall house the power transformers, fuses, switches, and bus connections for the electrical power. The utilities support module shall also contain any compressed system and compressed air conditioning hardware (regulators and air drying equipment) that may be required to drive the multi-port sampling channels. If a vacuum is required for driving the sampling system, it may be supplied with either a jet-pump pair or with a vacuum system. Both vacuum and pressure sources shall contain accumulators to enhance operational efficiency and provide constant vacuum and pressure levels for use by the sampling system. This vacuum source shall also be housed in this utilities support module. All exhausted air from the compressor or vacuum source shall be exhausted into the tank dome air space. The total exhaust flow rate and volume shall not create a safety issue or have an unacceptable impact on the tank's exhaust system. The utilities support module shall also contain a water reservoir that will be replenished from a portable water tank. The water reservoir and all compressed air and water piping shall be heat trace wrapped to prevent freezing in the range of temperatures expected at the tank farm. Status sensors and actuators needed on the utilities support module shall be electrically connected to the control system with their indicators located on a control panel. The utilities support module shall be mounted on a skid located near to the sampling module and the control system.

3.1.3 Major Component List

Figure 1 shows one potential embodiment of a conceptual sampling system, based on a discrete number of sampling channels (nested, fixed-depth sampling system) in a conceptual PHMC feed tank (AP-102 and/or AP-104 double-shell waste tanks) deployment. The sub-systems of the sampling system shall consist of a:

- Multi-port sampler
- Riser interface module
- Sampling module
- Control system
- Utilities support module.

3.1.4 Government-Furnished Property Lists

(This section TBD.)

3.1.5 Government-Loaned Property Lists

(Not applicable.)

3.2 SAMPLING SYSTEM/COMPONENT REQUIREMENTS

The sampling system shall be capable of filling and packaging, in 500-ml bottles, 15 liters of tank waste, having the physical and chemical properties ,as defined in Section 3.2.1.5.2 below, within an eight-hour (maximum) time period. Other criteria that the system shall meet in this sampling performance are defined below.

3.2.1 Sampling System Performance Requirements

The sampling system shall be used to extract representative waste samples from the PHMC feed tanks (AP-102 and AP-104) that will supply envelope A, B, and C LAW and envelope D HLW to support the privatization contract (see Appendix A). Figure 1 shows a conceptual sampling system deployed in a PHMC feed tank (AP-102 and/or AP-104 double-shell waste tanks). Other components not shown in Figure 1 include the sample container.

3.2.1.1 Sample Container

The sampling system shall have the means to fill a 500-ml sample bottle with waste representative of that at the sampling level from which it is extracted in the tank. The sample bottle, including the sealed plastic bag (for contamination control), shall fit within the dimensional limits of the "Safesend"™ and Steel Pig carriers (maximum length of 7.5 in. and a maximum diameter of 3.36 in.) without using force for insertion or removal.(The current Hanford "grab" sample bottle is glass bottle, 2.703 in. O.D. x 6.672 in. long - Owens-Brockway bottle C-7651 (drawing FR-16990-A-2), without a screw cap). The material of construction of the sample bottle and its closure/cap that are intended to make contact with the tank waste shall be compatible with the sampled waste and not introduce contamination into the waste.

3.2.1.1.1 Sample Bottle Fill Volume

The sampling system shall be capable of filling the 500-ml sample bottle to within a minimum of 90% of available space in the bottle. Available capacity shall be defined as the volume of the sample bottle when the bottle closure is in place. The sampling station and sample bottle shall be designed to allow simple remote mechanical manipulator hardware to insert and remove bottles from the sampling station with no loss of tank waste and no outer contamination of the bottle with tank waste. (Note: Sample fill volume of 100% is desirable and may become a requirement if the samples are drawn to provide waste materials for Resource Conservation and Recovery Act (RCRA) volatile organics analyses purposes. RCRA compliant sampling will also require that the sample bottle filling methodology does not degrade the waste sample, including its volatiles and trapped gas contents, during the filling process.)

3.2.1.1.2 Sampling Speed (Volume/Unit of Time

The sampling system shall be capable of extracting up to 15 liters of tank waste over a maximum of an eight-hour time period, including sampling from all sampling elevations within the tank (see Section 3.1.1.1 above) and the completion of pre-packing of all sample containers for shipment with the Hanford-shielded Pig transportation systems with wastes that have the range of chemical and physical properties defined in Section 3.2.1.5.2 below. In addition, this sampling time shall not be exceeded as a result of impacts from other in-tank operations, including tank mixing, decanting, etc. Adverse weather conditions that currently affect the baseline grab sampling method but are acceptable for this sampling system shall not impact the sampling time or performance.

3.2.1.1.3 Sample Container Packaging

The sampling system shall provide the means to pre-package (capping, decontamination of the outer container surfaces, and bagging) and place the "packaged" bottles into the "Safesend"™ over-pack and/or Steel Pig for transportation by the Hanford site's shipping Pig transport system. The bottle packaging operations shall be a manual operation, completed by an operator, through glove ports with lead-shielded gloves. The operator shall have a window(s) to view these operations. Decontamination shall be remotely completed when the sample bottle is in the sampling chamber.

3.2.1.2 Operational Life-Time

The nested, fixed-depth sampling system shall provide waste sampling over the 20-year lifetime of the Phase 1 B privatization contract. Over this lifetime, the sampling system shall provide representative waste sampling with wastes that have the chemical and physical properties identified in Section 3.2.1.5.2. The system shall be capable of providing at least 15 liters of tank waste for each waste batch that will be transferred to BNFL during this contract period (it is estimated that the sampling system will pump a minimum of about 1,500 liters of waste per year).

3.2.1.3 Waste Depth Sensor Interface

The sampling system shall avoid injecting gases into the tank headspace for sampling channels that are above the waste depth. Excessive gas injection into the headspace may adversely affect the air balance of the tank. The sampling system may require tank waste depth information from the tank's waste depth sensor system (Enraf 854 ATG level detector manufactured by Enraf-Nonius Service Corp., Bohemia, NY) for logic functions in the control of the sampling system, including the potential deactivation of sampling channels that are above the waste level in the tank. Other methods of disabling above waste sampling can also be used, such as the use of pressure sensors monitoring drive cycles of fluidic-based samplers.

3.2.1.4 Out-Of-Tank Physical and Chemical Environment

Out-of tank components, which reside at ground level above the waste tank, shall be designed and constructed to survive in the following environmental conditions:

- Temperature Range:
    - Operating: -20 to 120 °F
    - Non-operating: -20 to 150 °F
- Relative humidity: 4 to 100%
- Wind speed: Maximum of 80 mph, standby condition, 25 mph maximum operating condition.
- Moisture:

    - Rainfall up to 2 in./hr
    - Snow accumulation of up to 2 ft
- Dust: Capable of withstanding blowing sand and dust.

3.2.1.5 Representative Waste Sampling

The sampling system shall extract waste samples that are representative of the tank wastes at each sampling point within the tank. The extracted wastes shall have physical, chemical, and radiological characteristics that are within +/- 5 % of the mean values (within a 95% confidence level) of the reference material surrounding the sampling channel inlet (grab sampling is the preferred method for acquiring reference materials around an inlet). As a minimum, the sampling system shall extract independent waste samples from at least eight elevations in the PHMC waste feed tank. The locations of these inlets should be at 30, 25, 20, 15, 9, 6, 3, and 1 ft above the bottom of the waste tank. These locations may require adjusting, based on the space available for the sampling system hardware. However, all changes must be approved by the PHMC before being incorporated into any test system or system design.

3.2.1.5.1 Sampling Performance/Interferences

The sampling system shall provide representative waste samples that are not impacted by the depth of the waste in the tank, location of the sampling inlet in the tank, the range of physical and chemical properties of the waste, and the fluidic actions of the mixer pump and other in-tank hardware. Specifically, the ability to obtain samples with representative solid contents (particulate distributions) and chemical properties shall not be impacted by in-tank hardware and operation of this hardware.

3.2.1.5.2 Waste Sample Chemical and Physical Property Ranges

All sampling system surfaces that may contact the tank waste shall be capable of surviving waste with the following range of chemical, physical, and radiological properties:

- Temperature range: 50 to 200 °F
- pH: 7-14
- Specific Gravity: Average 1.0-1.6
- Viscosity: 1-80 cp
- Radioactivity: 1000 rad/hr
- Particle size: (see Appendix B)

- Solids content: 35% by wt. Maximum
- Chemical composition: (see Appendix A)

3.2.1.5.3 In-Tank Dome Space Physical and Chemical Environment

All sampling system components which reside in the tank air space above the waste shall be designed and constructed to survive the following physical and chemical environmental conditions:

- Temperature range: 50 to 200 °F
- Relative humidity: 10 to 100%
- Radiological: 10-10,000 rad/hr
- Dripping liquid from dome
- Aerosols and airborne waste solids and liquids.

3.2.1.5.4 Additives to the Tank and Tank Wastes

The sampling system, in all of its operations, shall not add solids or liquids to the tank and/or tank wastes that are outside of the current tank waste species envelop.

As indicated in Section 3.1.2.2.4 above, the drive gas from the pneumatic driver (jet pump) can be exhausted to the tank dome airspace. However, the gas exhausted to the tank will not exceed the following criteria:

- Peak flow rate into the tank exhaust system of less than 100 SCFM (Standard Cubic Feet per Minute)
- An average flow rate less than 40 SCFM under all sampling system operating conditions.

These limits are valid for normal sampling operations and any off-normal operations, such as unplugging, and are valid over the full range of optimized operating parameters (drive pressures, vacuums, and etc.) identified to produce optimized sampling with all sampling channels and with the full range of waste properties (Section 3.2.1.5.2).

3.2.1.5.5 Sample Temperature Control

All above grade sampling system components (located above the tank riser) that make contact with the tank waste shall include heating and cooling capabilities to maintain the waste temperature within +/- 5 °F of the waste temperature inside the tank. The above ground system modules shall have means to prevent freezing and overheating of fluids and of electrical and fluidic systems. This specifically includes the reservoir and piping/fluidic components containing water for flushing/purging operations.

3.2.1.6 Waste Temperature Measurement

A thermocouple sensor shall be located at each waste sampling point inside the tank and shall measure the temperature of the waste being sampled at that elevation. The temperature sensor mount shall minimize temperature errors from any part of the mounting or supporting hardware. The sensor shall measure waste temperatures within 5% of the actual waste temperature, with a 95% confidence level.

3.2.2 Physical Requirements

The sampling system shall be deployed within an existing 12-inch riser in waste tanks AP-102 and/or AP-104, with the multi-port sampler module deployed inside the riser as indicated in Figure 1. The multi-port sampler module shall either have the inherent structural strength or shall include a removable strong-back that will allow it to be raised from a horizontal position to a vertical position using a two-point crane hookup during installation into the riser. The use of the removable strong-back is not a preferred option but may be used if structural weight is a design issue.

3.2.2.1 Tank Interface Dimensions

The envelope of the tank that the sampling system will be deployed in shall include the following:

- Distance from tank bottom to highest waste elevation in the sampling system is 57 ft.
- Tank riser diameter of approximately 12 inches
- Diameter of hardware that shall be inserted into the tank riser shall be less than or equal to 10.5 inches.
- Waste depth range within the tank from less than 1 ft. (empty) to 35 ft. (full tank).
- Minimum distance from the bottom of the riser to the waste surface is approximately 10 ft.

3.2.2.2 Tank Riser and Dome Loading

The sampling system shall be deployed in the riser such that the riser supports a minimum of the vertical and horizontal loading from the multi-port sampler. For the feed tanks, the allowable loads are as follows:

- The maximum allowed vertical load that may be transferred to the tank riser is less than 4,000 lbs.
- The maximum moment that may be imparted to the top of the riser is less than 16,000 ft/lbs.
- Maximum load on the tank dome from all of the sampling system hardware is (TBD).

Note: The sampling system shall be subjected to a 600-lb cyclic horizontal load one foot from the bottom of the tank caused by the action of the tank mixer pump, which shall be operational during sampling evolutions.

However, in no case should the sampling system impart loads to the tank riser that exceed 10% of these limits.

3.2.2.3 Sampling System Radiation Shielding

The sampling system design shall be based on concepts that support ALARA. The sampling module shall include shielding for each part of the module that contains tank waste, including the sampling module (sampling and packaging chambers), riser interface, at-tank analysis system interface, and multi-port sampler module. The shielding shall be designed to reduce the maximum exposure to an operator to 10-20 mR/hr over an eight hour time operating time period, during which at least 15 liters of sample are extracted. In addition, the shielding shall be designed to allow an operator to complete bag-out operations for the removal of the system while maintaining exposure levels at or below this limit.

3.2.2.4 Sampling Modules Insect and Rodent Proofing

All enclosures/cabinets for the out-of-tank components, including the sampling module, riser interface module, and utilities support module, shall be insect and rodent proofed.

3.2.2.5 Sampling System Contamination

Currently, the AP-102 and AP-104 tank headspace is maintained at a negative pressure, relative to atmospheric pressure, by the tank farm exhaust system. The sampling system (multi-port module, tank riser interface module, and sampling station module) shall be designed to prevent an ingress of tank gasses and aerosols into the sampling system modules during all operations of the sampling system (sampling, sample container decontamination, packaging, etc.). In addition, all sampling system modules that will contain tank waste shall be gas-sealed modules to prevent the escape of tank waste liquids, solids, aerosols, and gases to the atmosphere during all operations with the sampling system. The sampling system shall be designed to maintain its pressure at a level that is between atmospheric pressure and the pressure in the tank headspace. The tank pressure will be in the –1.5 to –2.0 in of water range. The seal integrity of the multi-port sampler shall be verified with helium leak testing methods. The vendor shall identify and perform leak testing that demonstrates the gas-sealed status of the sampling module and the riser interface module. The test methods will be approved by the PHMC prior to implementing testing.

3.2.2.6 Sampling System Decontamination

The system shall be designed so that it is self draining (gravity) with the waste and purge/flush materials being returned to the waste tank. All components that make contact with the tank wastes shall be capable of being decontaminated with water purge/flushing to acceptable levels where the components can be safely removed from the tank and disposed of. The sampling chamber shall include water spray nozzles that will be used to wash down the sampling chamber and the outer surfaces of a sample container with the flushed tank wastes being drained into the waste tank. The total volume of water drained into the waste tank shall not exceed (TBD) gallons per sampling campaign. All surfaces making contact with the waste shall be designed to have waste flowing past the surface to prevent cross-contamination between samples (the design shall have no "dead" areas where waste can accumulate). The riser interface module design shall incorporate a spray ring to wash down/decontaminate the in-tank assembly before it is removed from the tank.

3.2.2.7 Sampling System Recovery From Plugging

The sampling system shall be capable of resuming operation after expended downtime periods (24-hour time period) where waste is allowed to sit in a stagnate condition within the multi-port sampling module. The system shall be able to recover (without being removed from the tank) and resume standard operation after being plugged from waste particulate settling or from the precipitation of chemically saturated wastes within a 4-hour time period. The pressures required to unplug a channel shall not exceed pressure limits for any of the fluidic components, including the upper pressure limit for no spitting from the sampling needle. All of the waste contacting surfaces shall have the capability to be flushed with water. Each sampling channel (sampling channel, valves, etc.) shall have the means for purging/flushing with water that removes residual waste as part of the procedures to prepare the system for shut-down between sampling campaigns. The waste contacting surfaces shall be designed so that all surface areas are contacted with flowing, purge water that is used to flush out the sampling system.

3.2.2.8 At-Tank Analysis Waste Stream Interface

The sampling station within the sampling module shall provide for a waste flow-stream that will be the interface for an at-tank analysis system. The interface will be a spool-piece, down-stream from the bottle sampling module. (Note: More details will be added to further define this interface in future document revisions.)

3.2.3 Reliability Requirements

The sampling system shall have an operational lifetime of 20 years (expected time for the privatization contract), with minor repair and maintenance for only out-of-tank hardware (riser interface module, sampling module, control system, and utilities support module) and shall perform representative waste sampling, as indicated in Section 3.2.1.2 above. The hardware that is inside the tank riser and tank dome/waste space shall not require repair or maintenance over this expected operational lifetime. The vendor shall identify the system components that will require maintenance and repair and shall provide a maintenance and repair schedule for these components.

3.2.3.1 Sampling Performance Requirements

The sampling system shall provide representative waste samples that have physical, chemical, and radiological characteristics that are within 5.0% of the mean values (with a 95% confidence level) of the tank waste surrounding a sampling channel inlet. The preferred method for providing reference material is the baseline grab sampling process. The sampling system shall be capable of providing representative samples over the expected 20 year operating life-time of the sampling system.

3.2.4 Maintainability Requirements

The sampling system components that are located internal to the waste tank (all of the components on the multi-port sampler that are below the tank riser flange) shall be designed for zero maintenance over the expected lifetime (20 years) of the sampling system. The balance of the sampling system shall have maintainability equal to or better than the following:

3.2.4.1 Fail-Safe Design Requirement

The sampling system shall be designed to fail safe, such that in the event of a component or module failure or an off-normal event, the system shall cease operation in a safe manner that will allow failure assessment, repair, and maintenance to proceed in a safe manner.

3.2.4.2 Maintenance Intervals

The riser interface module, sampling module, control system, and utilities support module shall be designed so that any required maintenance shall have minimum impact on the availability of the sampling system. The minimum time between required maintenance and repair actions shall be greater than 60 days, which is the estimated time needed to complete a tank waste material assessment and transfer campaign. These sampling system modules shall be designed and documented so that the required maintenance and repair can be completed with tank farms personnel.

3.2.4.3 Maintenance and Repair

The preferred mode of maintenance and repair shall be direct component replacement, with the potential for off-line repair of components. The out-of-tank components and modules shall be designed such that all maintenance and diagnostics can be quickly completed in the field with component replacements. The maintenance and operations document shall identify all maintenance and repair procedures for all of the system components. This document shall also contain a list of spare components/parts that should be inventoried for the sampling system.

3.2.4.4 Containment During Maintenance and Repair

The sampling module and riser interface module shall be designed such that during any required maintenance, periodic and long-term, containment of all radioactive material, including solids, liquids, gases, and aerosols is maintained. All valves and actuators shall be designed to be replaced without requiring the setup of contamination control tents and the use of either air purifying respirators (APR) or temporary air filtering systems.

3.2.5 Operating Environmental Requirements

The sampling system shall be designed to sample and handle the radioactive tank waste with the physical, chemical, and radioactive properties listed in Section 3.2.1 above.

3.2.5.1 Waste Contacting Components

All components that contact the waste shall be capable of handling and operating with waste materials having the chemical, physical, and radiological properties listed in Section 3.2.1.5.2 above.

3.2.5.2 Tank Dome Space Components

All components that reside in or contact the atmosphere from the tank dome space shall be capable of operating in an environment with the chemical, physical, and radiological properties listed in Section 3.2.1.5.3 above..

3.2.5.3 Out-of-Tank Space Components

All components which reside in or contact the atmosphere around and above the tank riser shall be capable of operating in an environment with the chemical, physical, and radiological properties listed in section 3.2.1.4 above. In addition, the out-of-tank components shall be designed to prevent ingress of insects and rodents.

3.2.6 Heat Generation and Spark Resistance Requirements

All electrical equipment within the waste confined space of the sampling system, where there is the potential for tank waste gas and aerosols to reside, shall comply with the safety and flammable gas criteria/conditions established for systems that are deployed in Facility Group 1 underground storage tanks (HNF-SD-WM-TSR-006, Rev, 0.). The electrical equipment shall be designed to meet NFPA 70, Class I Division 1 Group B criteria or provide equivalent safety.

3.2.6.1 Spark Resistance Requirements

Waste intrusive equipment and tank dome intrusive equipment shall meet the following spark resistance requirements:

- The mechanical tooling, equipment, and materials shall be constructed of spark-resistant material or rendered incapable of sparking with sufficient energy to combust a flammable hydrogen gas atmosphere.
- Electrostatic ignition sources shall be controlled by providing electrical bonding and grounding for all of the sampling components.
- Any exposed polymer materials shall be rendered incapable of electrostatic charge or discharge.

3.2.6.2 Heat Generation Requirements

Waste intrusive equipment and tank dome intrusive equipment shall meet the following heat generation requirements:

- Surface temperatures of heat generating devices that make contact with the tank waste shall be less than 320° F.
- Items that do not make contact with the tank waste shall not exceed 780° F (flammable gas ignition source requirements).

However, the design of the sampling system shall avoid, to the extent possible, temperatures that approach or are near temperatures at which the tank wastes will boil.

3.2.7 System Transportability Requirements

The sampling system must be designed to be transported over federal, state, and county highways. The dimensions and weight of each module with its packaging shall be included in the system documentation.

3.2.7.1 Transportation Packaging and Handling Requirements

The control system, utilities support module, and sampling module shall be packaged and adequately protected to prevent damage during transportation. Although a preferred method of lifting and/or transporting each module shall be identified and included in the system documentation. At a minimum, these modules shall be designed for conventional transportation with flat bed or covered truck transportation. This shall include the use of attached pallets and clearly identified lifting eyelets and/or designated lifting lift-points on the hardware modules. The location of these lifting eyelets and lift-points and their limitations shall be included with the system documentation.

3.2.7.2 Multi-Port Sampler Transportation/Deployment Requirements

The multi-port sampler shall be designed to be deployed vertically in the tank riser, but shall be transported in a horizontal position. The design and packaging shall be adequate to prevent damage to the module integrity or functionality. Length and weight limits for normal highway transportation of this module may be exceeded, if documentation is provided to facilitate the acquisition of special transportation permits. The use of removable strong-back structures may be used to support the multi-port sampler during transportation and in-tank deployment. However, the multi-port sampler may be designed with the inherent structural strength to be deployed without the assistance of a strong back, provided that the total weight and loading limits for the tank riser and tank dome are not exceeded.

3.3 DESIGN AND CONSTRUCTION REQUIREMENTS

The system design shall follow the general design guidelines provided by DOE Order 6430.1A. (Additional information TBD)

3.3.1 Materials, Processes, And Parts

The system shall comply with the requirements of HNF-PRO-451, *Regulated Substance Management*. All components that may contact the waste shall be constructed of stainless steel or demonstrated to be compatible with the environmental conditions specified in Section 3.2.5. All materials used for construction of the sampling system shall be new and free of defects.

3.3.2 Electromagnetic Radiation

The system shall comply with electromagnetic radiation emission requirements set forth in 47 CFR 15, Subpart B.

3.3.3 Equipment Labeling and Nameplates

Equipment and any parts of that equipment, including equipment to be used by operating and maintenance personnel, shall be clearly identified with appropriate labels and/or nameplates. Both nameplates and labels may be used with the sampling system equipment. Equipment and equipment parts include, but are not limited to, system and sub-system component groupings, individual components, control positions or modes, display markings, instructions, procedure manuals, storage spaces, access panels, spare components and modules, and tools. Nameplates shall be used to identify the major system modules and components. Labels and/or nameplates shall also be used to identify sub-components.

3.3.3.1 Nameplates And Product Marking Requirements

The system nameplates and label markings shall comply with the requirements of DOE Order 6430.1A, Section 1300-12.4.11, specifically with the following. Specific guidelines for addressing labeling considerations are contained in NUREG 0700, Section 6.6.; and MIL-STD-1472C, Section 5.5.

3.3.3.2 Nameplate and Label Design

The design of the nameplates and labels shall be consistent throughout the whole sampling system and its documentation. Nameplates shall be attached to the specific component or equipment in such a manner that environmental conditions or usage by personnel will not remove or destroy them.

3.3.3.2.1 Label Survivability

Labels and name plates shall be designed to survive in their environments and be readable over the expected 20-year lifetime of the sampling system (see Section 3.2.5).

3.3.3.3 Temporary Nameplates and Labels

Temporary nameplates and labeling shall be used only when necessary, shall be controlled administratively, and shall be replaced with permanent labels and nameplates before the equipment is made ready for testing and field deployment. The nameplate and labeling criteria described in this section shall also apply to the temporary labels.

3.3.3.4 Nameplate and Label Attachment

Various methods of nameplate and label attachment may be used, provided the attachment method is consistent with the system components environment and does not interfere with the part's function. Labels may be imprinted on the surfaces of components and hardware, providing the imprinting does not interfere with the function of the components and meets visibility and lifetime criteria.

3.3.3.5 Alpha-Numeric Fonts and Visibility

Numbers, symbols, and letter fonts may be used on labels and nameplates. The alpha-numeric data on labels and nameplates shall be legible and conform to human visual capabilities and limitations in regard to physical characteristics, such as letter and symbol size, contrast, font simplicity, spacing, and stroke. Labels and nameplates shall be visible and readable over the 20-year lifetime of the sampling system. Various equipment labels placed on the same or similar pieces of equipment and serving similar functions shall use the same material, color, font type, relative location to component, general format, and other configuration features to promote simplicity and avoid clutter. Label design shall be consistent, including the use of abbreviations and acronyms, label size, color and font. Smaller labels may be used on components if the label interferes with the functioning of the component.

3.3.3.6 Nameplate and Label Information

The labels shall indicate clearly and concisely the function and purpose of the item being labeled. Unnecessary information (e.g., information used only for manufacturing purposes) shall not be included on the label. Hierarchical labeling shall also be used to facilitate component location on control panels. The label information shall be easy to understand; words, symbols, and other markings in a label or instruction shall be unambiguous and accurate and the terminology used shall have commonly accepted meaning for all users.

3.3.4 Workmanship Requirements

(This section TBD)

3.3.5 Functional Test Requirements

(This section TBD)

3.3.6 Interchangeability Requirements

(This section TBD)

3.3.7 Safety Requirements

Design, installation, and operation of the system shall be in compliance with safety requirements and regulations contained within the PHMC (LMHC Subcontract No. 80232764-9-K-001), the Occupational Safety and Health, Fire Protection, and Nuclear Safety section of the DOE-approved TWRS-SRID (WHC-SD-MP-SRID-001), and the Integrated Environment, Safety and Health Management System (ISMS) Plan (HNF-MP-003). The SRID is a compilation of applicable state and federal requirements (including 29 CFR 1910 and 1926, and the Washington Administrative Codes), DOE Orders, and industry standards.

3.3.7.1 Safety Programs, Policies, and Procedures

Specific required industrial safety, industrial hygiene, fire protection, and nuclear safety programs, policies, and procedures that will be used in the development, fabrication and, testing of the nested, fixed-depth sampling system shall adhere to the PHMC policies and procedures located on the Hanford Intranet and in TWRS-specific procedures contained in HNF-IP-0842, TWRS Administration. The ISMS shall be used to integrate environment, safety, and health requirements into the work planning and execution processes. It is also located on the Hanford Intranet in PHMC Plans. Health and safety requirements for the individual tank farms shall be followed and are contained in the Tank Farm Health and Safety Plan (HASP) (HNF-SD-WM-HSP-002). Compliance with these requirements and regulations shall be ensured through safety involvement (which includes Industrial Safety, Industrial Hygiene, Fire Protection, and Nuclear Safety) in system design and operations planning and integration and through Safety review of engineering and operations documents.

3.3.7.2 Safety Evaluations

Prior to deployment of the system in the cold test facility, a Preliminary Safety Evaluation (PSE) shall be completed per HNF-PRO-703, Safety Analysis Process - New Project. As part of the PSE process, a preliminary hazards analysis shall be performed. The preliminary hazards analysis, which is used to support the project conceptual design, shall identify the hazards and available mitigating barriers and controls associated with the system and its operation.

The preliminary hazards assessment shall be expanded into a formal hazards assessment prior to in-tank hot deployment. The hazards analysis shall include all components and aspects of the sampling system and all of its potential operational modes (sampling, flushing, unplugging, etc.). The hazards analysis shall also include credible failures that might compromise the integrity of the waste tank, such as the failure of mounting brackets on the multi-port sampler and failure of the systems used to install the system.

3.3.7.2.1 Criticality Assessment

Although the TWRS tanks have been determined to have a very low probability of a criticality accident (not credible finding), a criticality assessment shall be completed with the nested, fixed-depth sampling system. The criticality assessment shall be part of the hazards analysis performed on the nested, fixed-depth sampling system.

3.3.7.2.2 USQ and/or Authorization Basis Modifications

As stated in Appendix A of HNF-PRO-703, an unreviewed safety question (USQ) screening/evaluation shall be completed for modifications to existing facilities. A USQ screening, as defined in HNF-IP-0842, TWRS Administration, Volume IV, section 5.4, Unreviewed Safety Questions, determines the approval authority of the proposed activity. Activities that are concluded to be outside the TWRS Authorization Basis (HNF-SD-WM-BIO-001 and HNF-SD-WM-TSR-006) shall be approved by DOE-RL. The need for an amendment to the existing safety basis documentation shall be determined as required by the facility safety basis documentation change control process of HNF-PRO-702, Safety Analysis Process - Facility Change or Modification.

3.3.8 Human Performance/Human Engineering Requirements

(This section TBD)

3.3.9 Decontamination And Decommissioning Requirements

The sampling system design shall include features that will facilitate decontamination for future decommissioning. All components making contact with tank wastes or sharing a tank waste environment shall be of a design and fabricated with materials and methods that can easily be decontaminated. Water shall be used in the decontamination of all sampler components. The following design principles to facilitate decontamination and decommissioning shall be considered:

- Construction materials shall have surface finish and/or coatings that inhibit the adhesion of waste materials to reduce the contamination from radioactive waste materials and to facilitate the removal of contamination when contact has been made with radioactive tank waste materials.
- Use of modular, separable confinements for radioactive materials to preclude contamination of fixed portions of the structure.
- Equipment designs, including effluent pathways for contaminated wastes, that preclude, to the extent practicable, the accumulation of radioactive or other hazardous materials in relatively inaccessible areas, including curves, cracks, and corners.
- Designs that ease cut-up, dismantlement, removal, and packaging of contaminated equipment from the facility (e.g., removal and dismantlement of structures, radioactive shielding, manipulator hardware, fixtures, and etc.).
- Use of modular radiation shielding, in lieu of or in addition to monolithic shielding walls
- Use of lifting lugs on large tanks and equipment to enable manipulation during decontamination/decommissioning.
- Systems design that are fully, self drainable, including piping systems and chambers.

3.3.9.1 Sampling Module Decontamination

The sampling module shall include means for decontaminating its interior surfaces and components (water spray nozzles for washing down the interior and all interior components). The sampling module shall be designed to assist in the natural drainage of the contaminated wash/purge water into the waste tank.

3.3.9.2 Valving, Piping, and Special Hardware Decontamination

All piping, valving, and special hardware within the multi-port sampler, riser interface module, and sampling module shall include means for flushing with water. The riser interface module will also include means to (nozzles to flush with water) to decontaminate the surfaces of the multi-port sampler as it is removed from the waste tank and means to drain the wash-down residue into the waste tank.

3.4 DOCUMENTATION

The design of the system shall be fully documented through the use of engineering drawings, specifications, vendor information, and supporting documents. Engineering drawings shall be prepared for the system/sub-ystem design in accordance with HNF-PRO-242, Engineering Drawing Requirements, utilizing drawing practices defined ASME Y14.5M. Specifications used to define components or for procurement of items shall be prepared, approved, and released in accordance with HNF-PRO-241, Engineering Specification Requirements. All commercially available components used in the construction of the system shall have accompanying documentation (catalog cut sheets, vendor information indicating relevant design attributes) that shall be approved and released in accordance with HNF-PRO-444, Vendor Information. In addition, all procured items shall be tested to verify and assure compliance with their design and performance basis.

3.5 LOGISTICS

3.5.1 Maintenance

(This section TBD)

3.5.2 Supply

(This section TBD)

3.5.3 Facility and Facility Equipment

(This section TBD)

3.6 PERSONNEL AND TRAINING

3.6.1 Personnel

The system shall be designed so that no more than two persons are required to operate the sampling system equipment. This does not include oversight and other supervisory personnel (Additional information for this section TBD).

3.6.2 Training

(This section TBD)

3.7 CHARACTERISTICS OF SUB ELEMENTS

(This section TBD)

3.8 PRECEDENCE

(This section TBD)

3.9 SECURITY

(This section TBD)

3.10 COMPUTER RESOURCE RESERVE CAPACITY

(This section TBD)

4.0 QUALITY ASSURANCE PROVISIONS

4.1 GENERAL QUALITY ASSURANCE PROVISIONS

Subcontractors supplying parts or services for the development, design, and fabrication of the nested, fixed depth sampling system shall implement a documented quality assurance program that meets the appropriate requirements of 10 CFR 830, " Nuclear Safety Management, Subpart A, General Provisions, Section 830.120, Quality Assurance Requirements, " Code of Federal Regulations. The program shall be submitted to Lockheed Martin Hanford Corporation (LMHC) Characterization Project (CP) Management for review and approval prior to initiation of work. LMHC CP also reserves the right to review and assess the subcontractor's program or program implementation with access to the vendor's and vendor sub-contractor facilities at any time during the performance of the contract.

4.2 MINIMUM QUALITY ASSURANCE PLAN REQUIREMENTS

As a minimum, the subcontractor's quality assurance plan shall include and have controls for:

- personnel training and qualification
- documentation and records
- design
- work processes
- inspection
- acceptance testing

4.2.1 Special Tests

All special testing required to meet quality assurance requirements shall be defined and approved prior to performance. The subcontractor shall develop and maintain a testing schedule. Any measuring and test equipment (M&TE) used in the testing process shall be calibrated and maintained. M&TE shall be calibrated to standards traceable to the National Institute of Standards And Technology (NIST).

4.2.1.1 Sampling System Performance Testing

The sampling system shall be required to pass a number of tests that demonstrate its performance prior to acceptance by the buyer. This initial system operational and acceptance testing shall be completed at the vendor's facilities. Testing with a prototype system, including formal Acceptance Testing and Operational Testing, shall also be completed at Hanford in a cold test site. The document HNF-3042, Rev. 1, "Test Plan for Evaluating the Operational Performance of the Prototype Nested, Fixed-Depth Fluidic Sampler" defines test requirements for the conceptual system. This document shall be revised prior to the completion of fabrication of the prototype sampling system to include tests for the prototype system. The vendor acceptance testing shall include:

- a basic demonstration of the operational status of all system features,
- testing of all operational and safety-related features, including temperature control, water flushing all waste contacting surfaces, remote sample bottle handling, decontamination of a sample bottle, and sample bottle packaging for transportation in the shielded Pig.

In addition, the system shall demonstrate the ability to extract representative waste samples with all sample channels, fill a 500-ml sample bottle, and demonstrate the safety features that are part of the sampling process design. Other acceptance test details will be identified when the prototype design is completed.

4.3 QUALITY ASSURANCE RESPONSIBILITY REQUIREMENTS

The subcontractor quality assurance program shall define responsibility and controls for personnel training and qualification, identification and disposition of nonconforming items, document and records, work processes, design, inspections and accepting testing, procurement, and assessments.

4.4 QUALITY CONFORMANCE INSPECTIONS

The subcontractor shall develop inspection plans, clearly defining both performance and acceptance criteria for all inspection processes. These plans shall be submitted to LMHC CP for review prior to performance of the inspections.

5.0 PREPARATION FOR DELIVERY

(This section TBD)

6.0 NOTES

(This section TBD)

7.0 REFERENCES

Powell, M. R. and M. W. Rinker, 1998a, *Simulant Specification for Nested Fixed-Depth Sampler*, Correspondence No. 9854073, Pacific Northwest National Laboratory, Richland, Washington.

Powell, M. R. and M. W. Rinker, 1998b, *Preliminary Set of Chemical Analytes and Physical Properties for Waste Monitoring*, Correspondence No. 9854071, Pacific Northwest National Laboratory, Richland, Washington.

Grenard, C. E., R. D. Claghorn, R. P. Marshall, jr., and M. A. deLamare, HNF-SD-WM-TRD-007, Rev. 0 DRAFT, "System Specification for the Double-Shell Tank System", April 1998, Flour Daniel Hanford, Inc., Richland, Washington.

Reich, F. R. and J.L. Smalley, HNF-3042, Rev. 1, " Test Plan for Evaluating the Operational Performance of the Prototype Nested, Fixed-Depth Fluidic Sampler", December 1998, completed by COGEMA Engineering Corp., Richland, Washington under contract with Lockheed Martin Hanford Corporation., Richland, Washington.

Tanks Waste Remediation System Privatization Contract DE-AC06-96RL13308, Mod. No. A006, 1996, U.S. Department of Energy, Richland, Washington.

APPENDIX A

Waste Envelopes

Waste Envelopes

A.1 Low Activity Waste (LAW) Envelopes

The Low Activity Wastes (LAW) specification in the Tank Waste Remediation Systems (TWRS) Privatization contract (Contract No. DE-AC06-96RL13308) establishes three waste envelopes for LAW, waste envelopes A, B, and C. Each waste envelope provides the compositional maximums of chemical and radioactive constituents in the waste feed to be treated. The concentration limits for the LAW feed to be transferred by DOE to the contractor for LAW services in Tables 1 and 2 apply to the soluble fraction only. The waste feed will be delivered with a sodium concentration between 3M and 10M and up to 2 weight percent solids (dry basis). The insoluble fraction characterization will include measurements of Al, Cr, P, S, Si, Na, TIC, TOC, ^{90}Sr, ^{137}Cs, ^{60}Co, ^{154}Eu, ^{155}Eu, and total alpha concentrations. Trace quantities of unspecified radionuclides, chemicals, and other impurities may be present in the waste feed. All feed (soluble and insoluble components) will meet the Tank Farm Operations specifications given in OSD-T-151-00007 (except for free hydroxide), the TWRS System Basis of Interim Operation (BIO) (WHC-SD-WM-BIO-001), and Technical Safety Requirements (WHC-SD-WM-TSR-006 Rev. E). The radiochemical inventory of the waste feed at the time of delivery shall be compared to the specification limits to assess compliance. The specifications for ^{60}Co, ^{154}Eu, and ^{155}Eu shall apply at the time of delivery for ILAW immobilization.

The LAW feed will not contain a visible separate organic phase, but will generate gases, including hydrogen and ammonia, at a nearly constant rate and a nearly uniform composition. The maximum ^{137}Cs concentration equivalent in the transferred feed shall be less than 6 Ci/liter. To handle the waste, permits, licenses, and other such regulatory approvals will be required in accordance with the requirements of Standard 4, "Safety, Health and Environmental Program" and Clause H.12, "Environmental Permits and Applications". Trace constituents, not previously identified through past characterization of Hanford tank waste and/or process testing, may be found in the LAW waste feed after start of Phase 1B.

A.1.1 Units of LAW Envelopes

Envelope A: The quantity of waste envelope A containing one metric ton of waste sodium shall equal one unit.

Envelope B: The quantity of waste envelope B containing one metric ton of waste sodium shall be the lesser of the following number of units: 2.6 units or X/Y units where X is equal to 20 weight percent sodium oxide loading in the ILAW glass and Y is equal to the achievable waste sodium oxide loading, for the particular waste feed. The waste loading limitations shall be based solely upon effects of chlorine, chromium, phosphate, and sulfate.

Envelope C: The quantity of waste envelope C containing one metric ton of waste sodium shall be the lesser of the following number of units:

1.15 units or X/Y units where X and Y are defined above. The waste loading limitations shall be based solely upon sodium additions required for cesium, technetium, strontium, and TRU removal from Envelope C for the particular waste feed.

A.1.2 References

WHC-SD-WM-BIO-001, Rev. E. September 1996, *Tank Waste Remediation System Basis for Interim Operation*. Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TSR-006, Revision E. October 1996, *Tank Waste Remediation System Technical Safety Requirements*, Section 5.7, "TWRS Technical Safety Requirements." Westinghouse Hanford Company, Richland, Washington.

Code of Federal Regulations, 10 CFR 61 "*Licensing Requirements for Land Disposal of Radioactive Waste*," U.S. Nuclear Regulatory Commission, Washington D.C.

OSD-T-151-00007. Rev. H-16. November 20, 1995. *Operating Specification for 241-AN, AP, AW, AY, AZ, and SY Tank Farms*. Westinghouse Hanford Company, Richland, Washington.

Table A- 1. LAW Chemical Composition, Soluble Fraction Only

CHEMICAL ANALYTE	Maximum Ratio: Analyte (mole) to Sodium (mole)		
	Envelope A	Envelope B	Envelope C
Al	2.5 E-01	2.5 E-01	2.5 E-01
Ba	1.0 E-04	1.0 E-04	1.0 E-04
Ca	4.0 E-02	4.0 E-02	4.0 E-02
Cd	4.0 E-03	4.0 E-03	4.0 E-03
Cl	3.7 E-02	8.9 E-02	3.7 E-02
Cr	6.9 E-03	2.0 E-02	6.9 E-03
F	9.1 E-02	2.0 E-01	9.1 E-02
Fe	1.0 E-02	1.0 E-02	1.0 E-02
Hg	1.4 E-05	1.4 E-05	1.4 E-05
K	1.8 E-01	1.8 E-01	1.8 E-01
La	8.3 E-05	8.3 E-05	8.3 E-05
Ni	3.0 E-03	3.0 E-03	3.0 E-03
NO_2	3.8 E-01	3.8 E-01	3.8 E-01
NO_3	8.0 E-01	8.0 E-01	8.0 E-01
Pb	6.8 E-04	6.8 E-04	6.8 E-04
PO_4	3.8 E-02	1.3 E-01	3.8 E-02
SO_4	1.0 E-02	7.0 E-02	2.0 E-02
TIC[1]	3.0 E-01	3.0 E-01	3.0 E-01
TOC[2]	5.0 E-01	5.0 E-01	5.0 E-01
U	1.2 E-03	1.2 E-03	1.2 E-03

Notes: 1.) Mole of inorganic carbon atoms/mole sodium

2.) Mole of organic carbon atoms/mole sodium.

Table A- 2. LAW Radionuclide Content, Soluble Fraction Only

	Maxim Ratio: Radionuclide (Bq) to sodium (mole)		
Radionuclide	Envelope A	Envelope B	Envelope C
TRU[2]	4.8 E+05	4.8 E+05	3.0 E+06
^{137} Cs	4.3 E+09	2.0 E +10	4.3 E+09
^{90} Sr	4.4 E+07	4.4 E+07	8.0 E+08
^{99} Tc	7.1 E+06	7.1 E+06	7.1 E+06
^{60} Co	6.1 E+04	6.1 E+04	3.7 E+05
^{154} Eu plus ^{155} Eu	1.2 E+06	1.2 E+06	4.3 E+06

Notes: 1.) The activity limit shall apply to the feed certification date.

2..) TRU is defined in accordance with 10 CFR Part 61.55.

Some radionuclides, such as ^{90}Sr and ^{137}Cs, have daughters with relatively short half-lives. These daughters have not been listed in this table. However, they are present in concentrations associated with the normal decay chains of the radionuclides.

A.2 High-Level Waste

The High-Level Waste (HLW) specification in the TWRS Privatization contract (Contract No. DE-AC06-96RL13308) identifies the slurry composition for the HLW and the unwashed solids composition (Envelope D). The HLW slurry will contain a mixture of liquids (Envelopes A, B, or C) and solids (Envelope D). The compositional range of the liquid fraction is defined above in Section A.1 for the LAW Envelope Definition. The radioactive specification for LAW does not apply to Envelope A, B, or C liquids in the HLW. The composition range of the Envelope D unwashed solids is given in Tables 3. 4, and 5. The feed concentration will be between 10 and 200 grams of unwashed solids/liter.

Compositions for Envelope D unwashed solids are defined in terms of elemental or anion concentrations and radionuclide activities per 100 grams equivalent non-volatile waste oxides. The non-volatile waste oxides include sodium oxide and silicon oxide. The feed components identified are waste components important to establishing the waste oxide loading in the HLW glass. Only these components have concentration limits that will be used to provide the basis for certification that the HLW feed is within specification limits. The concentrations of these components in the waste are not expected to be exceeded. Trace quantities of unspecified radionuclides, chemicals, and other impurities may be present in the waste feed.

The HLW feed will not contain a visible separate organic phase. The HLW will generate gases due to radiolysis, including hydrogen and ammonia, at a nearly constant rate and nearly uniform composition. To handle the HLW, permits, licenses, and other such regulatory approvals will be required. Trace constituents not previously identified through past characterization of Hanford tank waste and/or process testing may be found in the HLW feed after start of Phase 1B.

A 2.1 References

DOE/RL-88-21. 1996. *Double-Shell Tank System Unit Permit Application.* U.S. Department of Energy, Richland Operations Office, Richland, WA.

Table A- 3. High-Level Waste Feed Unwashed Solids Maximum Non-Volatile Component Composition (grams per 100 grams non-volatile waste oxides).

Non-Volatile Element	Maximum (grams/100 grams waste oxides)	Non-Volatile Element	Maximum (grams/100 grams waste oxides)
As	0.16	Pu	0.054
B	1.3	Rb	0.19
Be	0.065	Sb	0.84
Ce	0.81	Se	0.52
Co	0.45	Sr	0.52
Cs	0.58	Ta	0.03
Cu	0.48	Tc	0.26
Hg	0.1	Te	0.13
La	2.6	Th	0.52
Li	0.14	Tl	0.45
Mn	6.5	V	0.032
Mo	0.65	W	0.24
Nd	1.7	Y	0.16
Pr	035	Zn	0.42

Table A- 4. High-Level Waste Feed Unwashed Solids Maximum Volatile Component Composition (grams per 100 grams non-volatile waste oxides).

Volatile Components	Maximum (grams/ 100 grams waste oxides)
Cl	0.33
CO_3^{-2}	30
NO_2	36 (Total NO_2/ NO_3)as NO_3
NO_3	
TOC	11
CN	1.6
NH_3	1.6

Table A- 5. High-Level Waste Feed Unwashed Solids Maximum Radionuclide Composition (Curies per 100 grams non-volatile oxides).

Isotope	Maximum (Ci/ 100 grams waste oxides)	Isotope	Maximum (Ci/ 100 grams waste oxides)
^{3}H	6.5 E-05	^{154}Eu	5.2 E-02
^{14}C	6.5 E-6	^{155}Eu	2.9 E-02
^{60}Co	1 E-02	^{233}U	9.0 E-07
^{90}Sr	1 E+01	^{235}U	2.5 E-07
^{99}Tc	1.5 E-02	^{237}Np	7.4 E-05
^{125}Sb	3.2 E-02	^{238}Pu	3.5 E-04
^{126}Sn	1.5 E-04	2^{39}Pu	3.1 E-03
^{129}I	2.9 E-07	^{241}Pu	2.2 E-02
^{137} Cs	1.0 E+01	^{241}Am	9.0 E-02
^{152}Eu	4.8 E-04	$^{243+244}$Cm	3.0 E-03

Table A- 6. Additional High-Level Waste Feed Composition for Non-Volatile Components (grams per 100 grams non-volatile waste oxides).

Non-Volatile Element	Maximum (grams/ 100 grams waste oxides)	Non-Volatile Element	Maximum (grams/ 100 grams waste oxides)
Ag	0.55	Ni	2.4
Al	14	P	1.7
Ba	4.5	Pb	1.1
Bi	2.8	Pd	0.13
Ca	7.1	Rh	0.13
Cd	4.5	Ru	0.35
Cr	0.68	S	0.65
F	3.5	Si	19
Fe	29	Ti	1.3
K	1.3	U	14
Mg	2.1	Zr	15
Na	19		

APPENDIX B

Estimated Particle Size Distribution of Tank Wastes for the Phase 1B Contract

APPENDIX B

Estimated Particle Size Distribution of Tank Wastes for the Phase 1B Contract

Powell (1998a and 198b) et. al., identified particulate sizes that would be characteristic of the waste with which the sampling system must operate. The following are excerpts from Powell (1998a):

> Credible target values for the liquid density and viscosity are obtained from the range of properties exhibited by various sodium salts at a concentration of 3 molar, which is the minimum salt concentration allowed per the existing privatization contracts. Lide (1996) lists liquid density and viscosity data for sodium salts of carbonate, hydroxide, nitrate, and sulfate at various concentrations and 20° C. At 3 molar concentration, the lowest solution density is 1.12 g/mL (sodium hydroxide) and the lowest solution viscosity is about 1.3 cP (sodium nitrate). These properties are reasonably close to those of water, which at 20° C has a density of 0.998 g/mL and a viscosity of 1.0 cP.
>
> Samples taken from the non-convective layer of Tank 101-SY were analyzed by polarized light microscopy to measure the particle sizes of selected crystalline species (1992). The aggregates of salt crystals found in the samples ranged in size from roughly 50 to 500 microns and were relatively easy to break into smaller clumps. Size analysis on the insoluble particles in Tank 101-SY and other tanks have typically shown that the insoluble particles are largely in the sub-50 micron range (Willingham 1994). Based on these measurements, it appears as though the particles likely to be encountered by the nested, fixed-depth sampling system (NFDS) are in the sub-500 micron range.
>
> However, the Phase 1A privatization contracts specify an allowable particle size distribution that encompasses particles even larger than 500 microns. Because this size distribution is listed in the contracts, it seems prudent to ensure that the NFDS is capable of accurately sampling such a slurry. The particle size specification given in the Phase 1A privatization contracts is specifically for slurries returned from the vendor to DOE. However, because it is unlikely that the contractors will be processing the slurries in such a way as to change the particle size distribution (particularly the distribution of the insoluble solids), it is feasible to use this same particle size distribution as a guideline for

the worst-case slurries transferred from DOE to the privatization contractors. The particle size guidelines are given in Table 2 below.

Data from tank waste characterization suggest that the particle size distribution given in Table 2 may be overly conservative, but as mentioned before, it is not certain that the characterization data adequately reflect the full extent of possible particle sizes. For the purpose of NFDS performance validation testing, the size distribution given in Table 2 is judged to be appropriate.

Tank waste particle densities range from those of the relatively light salt crystals to the much heavier metal oxyhydroxide particles. Salt crystal densities are typically about 2.1 g/mL or higher.(1) The densities of insoluble metal oxide and hydroxide particles are typically higher, depending on the chemical compound in question. Measurements of sludge particle densities are not typically made as part of waste sample characterization. However, it is possible to estimate the average particle densities based on the reported bulk sludge density, the supernate density, and the weight percent undissolved solids in the sludge. This data is typically given in waste characterization reports. For sludge from Core 1 taken from Tank 101-AZ, for example, the sludge density was 1.7 g/mL, the supernate density was 1.2 g/mL, and the sludge was 52.3 wt% undissolved solids (Peterson et al. 1989). An average solids density of 2.74 g/mL is estimated from this measurement.

Table B- 1. Particle Size Range in Phase 1A Contracts

Particle Size Range (microns)	Allowable Weight Percent Solids in Size Range
> 4000 μm	0 wt.%
500 to 4000 μm	< 1 wt.%
50 to 500 μm	< 5 wt.%
< 50 μm	> ≈ 94 wt.%

(1)For example, sodium carbonate crystals have a density of 2.5 g/mL, sodium hydroxide is about 2.1 g/mL, sodium nitrate is about 2.3 g/mL, and sodium sulfate is about 2.7 g/mL

References

Lide, D. R., editor. 1996. *CRC Handbook of Chemistry and Physics.* CRC Press, Inc., New York, NY.

Willingham, C. E. 1994. *Thermophysical Properties of Hanford High-Level Tank Wastes - A Preliminary Survey of Recent Data.* PNL-9419, Pacific Northwest Laboratory, Richland, Washington.

Peterson, M. E., R. D. Scheele, and J. M. Tingey. 1989. *Characterization of the First Core Sample of Neutralized Current Acid Waste from Double-Shell Tank 101-AZ.* Letter Report prepared by Pacific Northwest Laboratory, Richland, Washington.

Powell, M. R. and M. W. Rinker, 1998a, *Simulant Specification for Nested Fixed-Depth Sampler*, Correspondence No. 9854073, Pacific Northwest National Laboratory, Richland, Washington.

Powell, M. R. and M. W. Rinker, 1998b, *Preliminary Set of Chemical Analytes and Physical Properties for Waste Monitoring*, Correspondence No. 9854071, Pacific Northwest National Laboratory, Richland, Washington.

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