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Nested, Fixed-Depth Fluidic Sampler and Analysis System

Deployment Strategy and Plan

Lockheed Martin Hanford Corporation

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EXECUTIVE SUMMARY

Under the Hanford Site Tank Waste Remediation System (TWRS) privatization strategy, the U.S. Department of Energy (DOE) requires the Project Hanford Management Contract (PHMC) Team to supply tank wastes to the Privatization Contractor for separation/treatment and immobilization (vitrification). Three low-activity waste (LAW) envelopes represent the range of types of liquid wastes in the large underground waste-storage tanks at the Hanford Site. The PHMC Team also is expected to supply high-level waste (HLW) to the Privatization Contractor. The HLW envelope is an aqueous slurry of insoluble suspended solids (sludge). The Phase I demonstration period will extend over 10 plus years. Wastes processed during this period will result in 6% to 13% of the total Hanford Site tank waste being treated.

The purpose of this document is to provide a strategy and top-level implementation plan for the demonstration and deployment of an alternative sampling technology as an improvement to the current grab sampling approach to support the TWRS privatization. Included in this work is the addition of the capability for some at-tank analysis to enhance the use of this technology for meeting the PHMC Team's needs. The first application of this technology is to LAW feed staging, then to HLW feed staging, and finally to cross-site transfer to support feed staging from 200 West Area tanks.

The TWRS retrieval and disposal mission readiness-to-proceed activities in the first quarter of Fiscal Year (FY) 1998 identified the primary uncertainties and risks that must be managed to successfully carry out the support of the TWRS Phase I activities. Four of the critical risks could be mitigated, at least partially, by the use of an improved alternative to grab sampling. In addition, eight of the risks with the Waste Feed Delivery Project were associated with the sampling activities. Over 25 logic elements, Technical Basis Reviews (TBR), were reviewed and found to be relevant to risk mitigation using an improved alternative to grab sampling. This document describes these risks and uses a methodology for risk analysis to determine a preliminary estimate of return on investment for pursuing an alternative sampling technology. The basis for the estimate will be firmed up as fiscal year multi-year work planning is conducted and the associated TBRs and cost estimating input sheets are updated. In this calculation the benefits were conservatively estimated to accrue only during the first five years of operation; with this assumption, a return of about double the original investment for development and deployment was projected.

The strategy for deployment focuses on development of the sampling concept for taking representative samples at various depths in a feed staging tank with the aid of some at-tank analysis capability to ensure that the sample is ready to be taken. A portion of the sample will be made available to the Privatization Contractor, and a portion will go to the PHMC Team's 222-S Analytical Laboratory. Using these results, DOE will transfer the waste to the Privatization Contractor. Given the current baseline plan and schedule, the proposed strategy is to demonstrate and deploy the capability for sampling LAW feed in a feed source tank first, so that the development activities will not interfere with the critical path activities for preparing LAW feed staging. When the hardware has been successfully demonstrated, the sampling and at-tank analysis capability will be deployed on the two PHMC Team LAW feed staging tanks.

Subsequently, the capability will be modified, if needed, and deployed on the HLW feed source/staging tanks and on the cross-site transfer staging tank in 200 West Area.

The development strategy for the sampling system will use a technology that has been successfully demonstrated in the past and will extend this technology to the present application, thus increasing the likelihood of success. Fluidic sampling was chosen as the preferred technology, because it has been used successfully in England for a number of years. The nested, fixed-depth fluidic sampling system was chosen because it is capable of operating under adverse weather conditions, will minimize the development effort because fixed-depth samplers have been used in the past, and will minimize the time it takes to obtain the samples because the sampling apparatus will not have to be moved. The application of this system will benefit from the deployment of the fixed-depth sampler at the Savannah River Site for waste that is similar to the waste at the Hanford Site. The development strategy will consist of AEA Technology Engineering Services, Inc. (AEA), the developer of the technology, testing the system concept cold at an existing test facility. The system then will be tested cold at the Hanford Site under conditions similar to actual operations. Hanford Site personnel will conduct these tests with support from AEA personnel. The system next will be tested hot in an actual double-shell tank at the Hanford Site.

The deployment plan represents an integrated project of DOE's Office of Science and Technology, EM-50, together with EM-30 Office of Waste Management. EM-50 will provide $700,000 in FY 1998 through its Tanks Focus Area, International Grants, and Robotics Cross-Cut Program. During this time, the EM-50 Accelerated Site Technology Deployment (ASTD) program, in cooperation with the High-Level Waste Management organization at the Savannah River Site, have funded installation of a fixed-depth sampler system at the Savannah River Site . At the Hanford Site, the TWRS Waste Retrieval Project has supported the initial planning of the sampler and analysis project through technology support tasks. In FYs 1999 and 2000, EM-50 continues to provide support for cold demonstration at the Hanford Site. EM-30 will fund the deployment of the sampling and analysis capability to support LAW feed staging at the Hanford Site, which is assumed to be in the FY 2002/FY 2003 timeframe. The planned support by EM-50 and EM-30 is summarized below. Additional deployments in the second LAW feed staging tank and in the 200 West Area cross-site transfer staging tank are assumed to be funded by EM-30 at a cost of $2.3 million each.

The incremental cost of development to support sampling and at-tank analysis of the HLW source/staging tanks is estimated to be $1.09 million. EM-50 is assumed to fund this in the FY 2000/FY 2001 timeframe. Deployment in each of the two HLW feed staging tanks is assumed to be funded by EM-30 at a total cost for the two tanks of about $5 million. All of the digits have been retained in the above cost estimates to ensure traceability throughout the document and to supporting documentation. In fact, these numbers are only preliminary planning numbers and, as such, have an uncertainty of perhaps ±25% or more.

Development and Deployment Costs for the Nested, Fixed-Depth Fluidic Sampler for Low-Activity Waste Feed Staging.

Funding source	Fiscal Year							Totals (EAC)*
	1998	1999	2000	2001	2002	2003	2004	
EM-50 (total $ in thousands)	$700	$1,680	$1,380	$1,500	--	--	--	$5,260
EM-30 (total $ in thousands)	$50	$225	$615	$660	$2,625	$2,300	$325	$6,800
Project (total $ in thousands)	$750	$1,905	$1,995	$2,160	$2,625	$2,300	$325	$12,060

*EAC = estimate at completion.

Development and Deployment Costs for Adding the Nested, Fixed-Depth Fluidic Sampler for High-Level Waste Feed Staging After it is Deployed for LAW Feed Staging.

Funding source	Fiscal year					Totals (EAC)*
	2000	2001	2002	2003	2004	
EM-50 (total $ in thousands)	$390	$700	--	--	--	$1,090
EM-30 (total $ in thousands)	--	--	--	$2,500	$2,500	$5,000
Project (total $ in thousands)	$390	$700	--	$2,500	$2,500	$6,090

*EAC = estimate at completion.

The Project Team includes personnel from (1) the TWRS Characterization Engineering organization to provide technical leadership, (2) the TWRS Process Waste Support organization to provide program support, (3) AEA to serve as the source of the power fluidic technology, and (4) Pacific Northwest National Laboratory to provide support both directly and through the Robotics Program. In FY 1999 the EM-50 Characterization, Monitoring, and Sensor Technology Cross-Cut Program will begin providing support and will involve other organizations with expertise to participate in development and deployment.

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LIST OF TERMS

AEA	AEA Technology Engineering Services, Inc.
ALARA	as low as reasonably achievable
DOE	U.S. Department of Energy
EM-30	DOE Office of Waste Management
EM-50	DOE Office of Science and Technology
FY	fiscal year
HLW	high-level waste
LAW	low-activity waste
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
SRS	Savannah River Site
TBR	Technical Basis Review
TFA	Tanks Focus Area
TWRS	Tank Waste Remediation System

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1.0 INTRODUCTION

1.1 BACKGROUND

Under the Hanford Site Tank Waste Remediation System (TWRS) privatization strategy embodied in the contract signed with BNFL, Inc., in September 1996, the U.S. Department of Energy (DOE) is purchasing services from a contractor-owned, contractor-operated facility using a fixed-price contract. The Project Hanford Management Contract (PHMC) Team will supply tank wastes to the Privatization Contractor for separation/treatment and immobilization (vitrification). Three low-activity waste (LAW) envelopes are identified for Phase I of the contracts. These represent the range of types of liquid wastes in the large underground waste-storage tanks at the Hanford Site: double-shell slurry/double-shell slurry feed (Envelope A); aging waste, also known as neutralized current acid waste (Envelope B); and organic complexant containing waste known as complexed concentrate (Envelope C). These wastes all will be delivered as dilute slurry solutions with a maximum of 5% by volume solids, which is expected in the updated contracts to change to 2% solids by weight. The contract is expected to include high-level waste (HLW) treatment services, and one HLW envelope will be provided. This envelope, Envelope D, is an aqueous slurry of insoluble suspended solids (sludge). The demonstration period will extend over 10 plus years. Wastes processed during this period will result in 6% to 13% of the total Hanford Site tank waste being treated.

In Fiscal Year (FY) 1996, DOE's Office of Science and Technology, EM-50, funded AEA Technology Engineering Services, Inc. (AEA), to install and operate a fluidics pump and sampler demonstration in Charlotte, North Carolina. In October 1996, the pump and sampler operation was demonstrated to personnel from the DOE, the contractor, and representatives from DOE's Oak Ridge, Savannah River, Idaho, and Hanford Sites. During the period immediately preceding this demonstration, AEA also completed a conceptual design report that included a fluidics sampler for Savannah River Site (SRS) Tank 49, one of the in-tank precipitation process tanks.

In September 1996 at the Hanford Site, the documentation of the alternatives generation and analysis was completed to address the question: What is the design basis for the facilities required to stage LAW feed to the Phase I Privatization Contractor? This Alternatives generation and analysis included the evaluation of three alternatives for sampling feed: grab sampling, core sampling, and the Isolok-Type Sampling System. The latter concept used the conceptual design done for the Grout Disposal Program to obtain representative samples of the feed batches in the staging tanks (Claghorn et al.1997). This evaluation is briefly summarized in Appendix D.

In the October to November 1996 timeframe, the decision panel, in considering the Alternatives generation and analysis, looked at the AEA fluidics sampler concept that was being pursued at SRS. The panel agreed at that time to continue with the grab sampler as the baseline approach to ensure that the baseline schedule was met. The panel also agreed that the Hanford Site should pursue seeking support through the Site Technology Coordinating Group Tank Subgroup to obtain funding to pursue the AEA approach as an improved alternative to the baseline. Assuming that the AEA concept worked as foreseen, it would be phased in to the baseline as soon as practical.

The proposal was written, was approved by the Site Technology Coordinating Group, and has resulted in the formation of the current integrated project. The EM-50 International Grants provided $300,000 to AEA in FY 1998 to support development of a nested, fixed-depth sampler system (initially called "Variable Depth Fluidics Sampling and Analysis"), which will be demonstrated at the end of FY 1998 in AEA facilities in Charlotte, North Carolina, using nonradioactive, simulant tank waste (Murray et al. 1998). The EM-50 Tanks Focus Area (TFA) provided $300,000 in FY 1998 to the PHMC Team to lead the development and deployment of the tank sampler and at-tank analysis system. The EM-50 Robotics Cross-Cut Program provided Pacific Northwest National Laboratory (PNNL) with $100,000 in FY 1998 to support the at-tank analysis portion of the overall system. The Accelerated Site Technology Deployment Program, in cooperation with the High-Level Waste Management organization at SRS, has funded a Technology Deployment Initiative in FY 1998 to install a fixed-depth sampler system in Tank 49 to support SRS's in-tank precipitation efforts. At the Hanford Site, the TWRS Waste Retrieval Project through its technology support task has supported the initial planning of the sampler and analysis project. Funds totaling approximately $50,000 permitted the first drafts of the Engineering Task Plan and Technology Task Plan to be formulated, several design concepts for the FY 1998 demonstration by AEA to be evaluated, a design concept to be selected, and cost account authorization and planning to be initiated.

AEA considered five fluidics sampler concepts as being feasible for achieving representative samples from the different depths of the waste in the TWRS feed staging tanks. The five concepts were telescoping, flexible hose, hoisting, slotted pipe, and the one selected: nested, fixed-depth. A Hanford Site team including PHMC Team and PNNL staff evaluated the alternatives and had a working session with AEA technical staff. The group selected the nested, fixed-depth concept, based upon a preliminary set of functions and requirements. The 32 criteria included safety, operability, maintainability, decontamination, environmental, sample shipping, as well as the Data Quality Objectives items.

1.2 PURPOSE

1.2.1 Purpose of the Document

This document has two primary purposes. The first purpose is to provide the strategy for the following:

1. Demonstration and deployment of the power fluidic sampling technology as an improved alternative to the current grab sampling approach for LAW feed staging to support the TWRS privatization;

2. Adding the capability for at-tank analysis to this sampling technology to provide additional support to the LAW feed staging;

3. Adding the capability for using this sampling and perhaps at-tank analysis technology to LAW feed source tanks including the 200 West Area SY Tank Farm and the related cross-site transfer;

4. Demonstration and deployment of the power fluidics sampling technology as an improved alternative to the current grab sampling and core sampling approaches for HLW feed staging to support the TWRS privatization; and

5. Adding the capability for at-tank analysis to this HLW sampling technology to provide additional support to the HLW feed staging.

The second purpose is to provide a top-level implementation plan for carrying out the strategy pertaining to LAW feed staging tanks (items 1 and 2 described above). This plan will include an approach to leveraging the EM-50 Technology Development Programs support for these technology development opportunities to achieve goals common to EM-50 and TWRS privatization. This document will serve as a basis for TWRS FY 1999 Multi-Year Work Plan definition and planning of support for the Nested, Fixed-Depth Fluidics Sampling and Analysis Project.

This implementation plan will focus on developing and deploying this sampling and possibly at-tank analysis technology on the LAW feed source and staging tanks. Only a brief discussion is included on the use of these systems in the 200 West Area SY Tank Farm and the related cross-site transfer (item 3) as well as the HLW feed source tanks (items 4 and 5 above). As development progresses, more emphasis will be placed on these deployments in later versions of this document.

1.2.2 Purpose of the Sampler and Analysis System

1.2.2.1 Existing Condition. Grab sampling is the baseline waste sampling approach. This system involves a bottle, stopper, weight, and wire rope. The advantages of this option are that it requires no construction and will have no impact on project schedule or other milestones. It is a fairly simple system, and all performance requirements are established. It is reliable and easily maintained. Disadvantages include the following:

- Moderate, recurring sample cost,
- Potential for the sample not to be repeatable at a given depth,
- Greatest personnel radiation exposure and potential for contamination (as low as reasonably achievable [ALARA] considerations),
- Somewhat time consuming (several hours to several days) to get samples from all depths,
- Inability to ensure a representative sample during tank waste settling,

- Inability to provide samples during mixer pump operation,
- Most susceptible sampling method to being delayed by bad weather conditions,
- Difficulty in acquiring the multiliter quantities now sought, and
- Not readily adaptable to increases in baseline throughput rate of feed staging (e.g., by a factor of 2).

1.2.2.2 New Condition Desired. A new sampling approach is proposed that uses a nested array of samplers, each a "1-in." diameter piping inlet and return line) that fit through a single "12-inch" riser on the desired LAW feed source or staging tanks to withdraw a sample from several discrete depths in the waste (ranging from near the top of the waste to near the bottom of the waste). Figure 1 shows the nested array deployed in a Hanford Site double-shell tank. Figure 2 is a schematic enlargement of a single sampler and at-tank analysis system with more of the details displayed. The sampler is pneumatically driven with compressed air to retrieve the samples into a sample holder on top of the riser that can then, without operator exposure, move the sample container into a cask for transfer to the Privatization Contractor or to the 222-S Laboratory. A further refinement will be to add robust monitoring instruments on the sampler apparatus to provide some information about the solids content, radionuclide content, and possibly chemical content of the waste before any samples are withdrawn from the tank.

The new sampler system involves a venturi pump, operating on the entrainment principle, with a specially designed sampling tee installed in the discharge pipework that delivers a sample of the liquid through a sample needle to the sample bottle. Such equipment has been used in United Kingdom nuclear installations over approximately 20 years. Over 400 systems have been installed with no failures. The sampler systems offer the following key benefits:

- Ability to obtain a controlled and representative sample;
- Reduced personnel radiation exposure because of a dramatic reduction in the potential for inadvertently spreading contamination during sampling, compared with manual sampling practices, and elimination of the need to remove or open a riser to obtain a sample;
- Reduced susceptibility to being delayed by bad weather conditions;
- Reduction of difficulty in acquiring the multiliter quantities that are now sought;
- Readily adaptable to the baseline throughput rate of feed staging to the Privatization Contractor being increased (e.g., by a factor of 2);
- Ability to ensure a representative sample during tank waste settling;

Figure 1. Nested, Fixed-Depth Fluidic Sampler and At-Tank Analysis System Schematic.

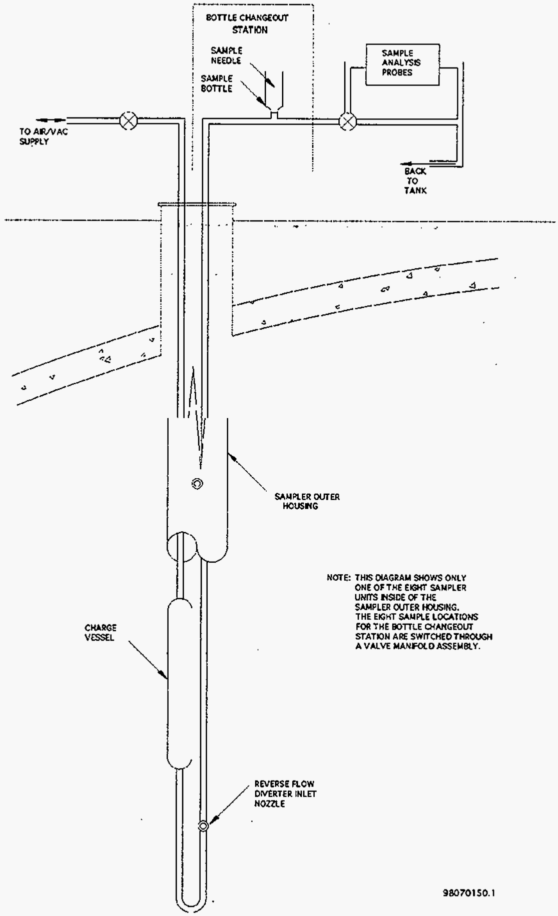

Figure 1. Nested, Fixed-Depth Fluidic Sampler and At-Tank Analysis System Schematic.

Figure 2. Nested, Fixed-Depth Fluidic Sampler Deployed in a Hanford Site Double-Shell Tank.

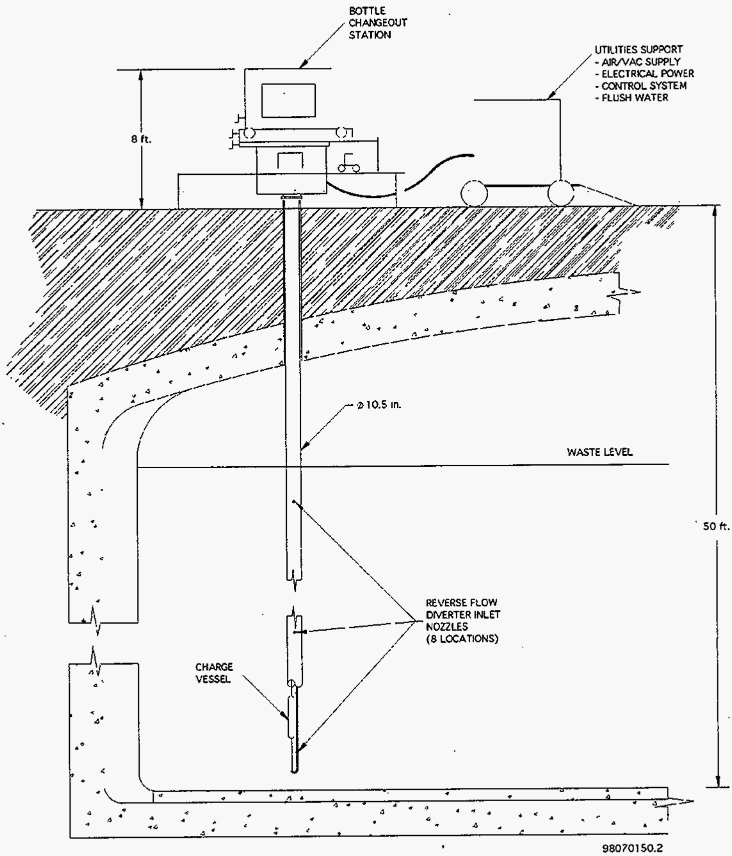

Figure 2. Nested, Fixed-Depth Fluidic Sampler Deployed in a Hanford Site Double-Shell Tank.

- Ability to provide samples during mixer pump operation;
- Greater ease of operation;
- Ability to be readily flush and decontaminate samplers because equipment has no crevices to trap contamination;
- Adaptable to some process control, on-line monitoring for timely decision making;
- Reduction of replacement costs for worn out components;
- Reduction of much routine maintenance;
- Reduction of secondary waste from worn out components;
- Reduction in the health physics and safety work associated with many of the above items;
- Direct adaptation of the fixed-depth fluidics sampling system being deployed and tested at the SRS; and
- Greater assurance that the PHMC Team and DOE will not be required to pay "idle facilities" time charges to the Privatization Contractor as a result of waste not being delivered on time and within envelope specifications (up to $1 million per day penalty costs).

1.2.2.3 Comparison of Operations of Existing and New Sampling and Analysis Approach. The operational logic diagrams for the existing approach and the new sampling and analysis approach for LAW feed are shown in Appendix A. The two logic diagrams, Figures A-1 and A-2, are essentially the same except that the existing approach has a logic block for transporting the process control samples to the laboratory, while the new approach does not have this logic block. Samples taken for process control include those taken after mixing, settling, or chemical adjustment. A comparison for one scenario of the operational schedule for the staging tank using the existing and new sampling and analysis approaches also is shown in Appendix A. The time to complete the sampling and analysis using the existing approach is about 181 days, compared to 141 days for the new approach. While this amount of time saving would not occur if the batch being staged required no adjustment, such an adjustment is likely to occur sometime during Phase I.

1.3 SCOPE

This document contains the missions, objectives, strategies, planning assumptions, proposed deployment scenario, schedule, funding needs, and proposed funding sources to support the demonstration and deployment of a nested, fixed-depth fluidics sampling and analysis system in the two PHMC Team LAW feed staging tanks, 241-AP-102 and 241-AP-104.

LAW feed source tanks (in both 200 East and 200 West Areas) and HLW feed source tanks will be included, if conditions warrant, in the FY 1999 revision to this Deployment Strategy and Plan.

1.4 MISSION AND OBJECTIVES

1.4.1 Mission

The mission of this Sampling and Analysis Project is to develop and demonstrate a capability for taking and analyzing representative samples rapidly to support staging feed successfully for the LAW/HLW Privatization Contractor in a safe and cost-efficient manner and with a minimum impact on tank space. The mission of this project supports the TWRS Waste Disposal Division Mission, which is to retrieve, treat, immobilize, store, and dispose of current and future highly radioactive Hanford Site tank waste in an environmentally sound, safe, secure, and cost-effective manner by 2028. The mission of this project also supports the TWRS Mission, which is to provide safe storage and management of the legacy and new waste, retrieval and disposal of the waste, decontamination and decommissioning of TWRS facilities, and closure of TWRS sites.

1.4.2 Objectives

The goals of the Sampling and Analysis Project are as follows:

- Achieve baseline sampling needs with assurance, which implies ensuring that float exists in the schedule to accommodate an iteration in the logic (e.g., the mixing isn't adequate, and more mixing is needed; the contents don't meet solids specification, and settling must be allowed; the contents don't meet chemicals specification, and some material must be pumped out and new feed material added, mixed, sampled, and analyzed);

- Be able to accommodate any bad weather outages that the Hanford Site has experienced in the last 25 years (e.g., from wind, snow, cold, and lightning);

- Reduce ALARA exposure and potential for personnel contamination;

- Accommodate sample size and quantities (e.g., 5 liters) sufficient to meet PHMC Team laboratory analysis needs, Privatization Contractor needs, and PHMC Team archiving needs; and

- Phase into usage, and into the baseline, in a way that supports risk reduction and does not increase risk (e.g., schedule risk).

The goals of this project also support the objectives of the TWRS Waste Disposal Division, which are derived from and are consistent with DOE Headquarters, Site- and TWRS-level objectives, and TWRS systems engineering. The objectives include:

- Minimize environmental, worker safety, and public health risks;
- Minimize costs;
- Maximize regulatory compliance, including the *Hanford Federal Facility Agreement and Consent Order* (referred to as the Tri-Party Agreement) (Ecology et al. 1996);
- Develop stakeholder confidence and acceptance; and
- Develop and deploy technology to solve Site and DOE complex problems.

The development of the sampler/analyzer systems also supports Section 2.2 TWRS Disposal Program Guidance, which includes: "Technology development will be supported to execute the Disposal Program strategy. Technology development opportunities with EM-50 Technology Development Programs will be leveraged wherever possible to achieve common goals. Priorities for technology activities shall be established (and altered, as necessary) through the Site Technology Coordination Group process."

The sampler/analyzer system supports Section 3.2.1, Program Planning, Basis for Planning, which includes: "Planning for the Waste Retrieval Project will reflect a tank waste retrieval and closure strategy that: 1. Provides envelope A, B, and C waste to the Privatization Contractor within 60 days prior to a requested waste transfer day in the amount assumed in the TWRS Process Flowsheet . . . . 17. Includes tank sampling and analysis from 2003 through 2011."

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2.0 STRATEGIES

2.1 DEVELOPMENT STRATEGY

The development strategy is a segmented approach that focuses on the two major systems (the sampling system and the analytical system) independently. This will facilitate deployment of the systems independently so that the benefit of one can be obtained even if the development of the other is unsuccessful. The development of the analytical system will lag that of the sampler, because the sampler's development is further along, the analytical system is more technically challenging, and the sampling system could be used even if the analytical system is not deployed.

The development strategy for the sampling system will use a technology that has been successfully demonstrated in the past and will extend this technology to the present application and thus increase the likelihood of success. Fluidic sampling was chosen as the preferred technology because it has been successfully used in England for a number of years. It is a highly reliable technology that has the capability of being designed to function under adverse weather conditions. The nested, fixed-depth fluidic sampling system was chosen because it is capable of operating under adverse weather conditions, will minimize the development effort because fixed-depth samplers have been used in the past, and will minimize the time it takes to obtain the samples because the sampling apparatus will not have to be moved. Application of this system will benefit from experience with the fixed-depth sampler at the SRS for waste similar to waste at the Hanford Site. The development strategy will consist of AEA, the developer of the technology, testing the system concept cold at an existing test facility. The system then will be tested cold at the Hanford Site under conditions similar to actual operations. Hanford Site personnel will conduct these tests with support from AEA personnel. The system next will be tested hot in an actual double-shell tank at the Hanford Site.

The development of the analytical system will focus on process control. Analysis will be required to determine if contractual confirmatory samples should be taken. Ideally, confirmatory samples would be taken if the tank is well mixed, if the tank is adequately settled (if required), and if the tank is likely to be within the specification envelope without further adjustments. The focus of the at-tank analysis will be to determine if the tank is well mixed or is adequately settled. No attempt will be made to determine if the tank is within the specification. Such determination would be extremely difficult without a full suite of chemical analyses. Aside from the cost of the equipment to do this complete suite, the operability and maintainability of these chemical analyte instruments in the field is quite poor. The strategy will be to select a limited number of simple, well-established technologies that can be successfully implemented in the field. Successful implementation will be judged not only on the ability to develop and install the hardware but also on the operability (reliability, availability, and maintainability) of the hardware in the field.

2.2 DEPLOYMENT STRATEGY

The strategy for deploying the sampler and analysis systems is to use a phased approach. By selecting early deployment phases that have a high likelihood of success and a relatively high payoff, the phased approach maximizes the benefits to DOE. Generally, the development and deployment will try to bring a capability to operational readiness with significant benefit as soon as possible, with additional capability being added to provide additional benefit in a staged manner.

The first phase of the strategy is to develop and deploy a fluidic sampler system for the LAW. Assuming successful demonstration of the system by AEA, the nested, fixed-depth fluidics sampler will be deployed. The first tank selected will depend on the schedule for development, the schedule for privatization implementation, and the interference caused by other construction activities in the tank farm. If the sampler can be brought on-line for the 241-AP-102 and 241-AP-104 feed staging tanks without adversely impacting the baseline efforts to support Privatization Contractor hot startup, then the sampling capability will be deployed in those tanks first. If adverse impacts are expected (e.g., congestion in and around 241-AP-102 and 241-AP-104 during readiness preparations), then the sampling capability will be deployed first on one of the LAW feed source tanks (e.g., 241-AN-105 or 241-AW-101). After the sampling capability is demonstrated and any improvements defined and possibly tested, then the sampling capability would be deployed on 241-AP-102 and 241-AP-104. The source tank selected will depend on the development schedule and the privatization schedule. The source tank selected will be from the group meeting Envelope A specifications, because only this group will require mixer pumps to operate during sampling. Because the plans are to decant the liquid from the Envelope A source tanks and dilute it to fill the first staging tank from a given source tank, this part of the source tank cycle would not allow testing of the sampler while mixing. Therefore it will be necessary to test the sampler in the second half of the source tank cycle, during which water will be added to the source tank and the tank will be mixed to dissolve the solids in it before the second staging tank is filled from a given source tank.

The second phase of the deployment strategy will be to bring at-tank analysis online for LAW feed. This analysis of the waste (physical, radionuclide, and chemical) will be done to enhance the schedule of processing the feed to ensure that the waste is ready for the confirmatory samples to be taken and analyzed at the 222-S Analytical Laboratory (and by the Privatization Contractor) to ensure that the waste is ready for transfer to the Privatization Contractor. Process steps that can be monitored with this capability include monitoring to know when sufficient mixing has occurred in the feed staging tank and monitoring to know when sufficient settling has occurred (if settling is needed to meet the feed specification).

The third phase will be to bring sampling (and at-tank analysis) to the source tanks in 200 West Area such as 241-SY-102 before initiating a cross-site transfer. This will ensure successful cross-site transfer of LAW feed, saltwell liquor pumping should it extend beyond the current finish date (April 2004) for Case 4 (see Ross et al. 1998), or Phase II single-shell tank retrieval.

The fourth phase will be to bring sampling and at-tank analysis to the HLW feed staging tanks to ensure that the feed is sufficiently pretreated and to provide the confirmatory samples to ensure that the HLW feed meets Envelope D specifications and is ready for transfer to the Privatization Contractor. The ability to sample and perform at-tank analysis may be considerably more difficult for the HLW sludge than for the LAW supernate; therefore, the development and deployment for the HLW feed will benefit from the lessons learned from developing and deploying the LAW feed staging sampling and at-tank analysis capability.

2.3 FUNDING STRATEGY

The funding strategy will be to seek funds from EM-50 to complete the system development and support the deployment of the first prototypical system. EM-30 funds will be sought to complete the deployment of the first prototypical system and subsequent deployments. EM-50 funding will be sought through the TFA. The TFA will involve other EM-50 programs as the opportunities to participate are identified. The TFA has involved multiple EM-50 programs in FY 1998. The International Grant will be used to support the development of the sampling system concept. The Robotics Program will be used to support the development of the analytical system concept. The TFA Program will support the integration of these systems into the Hanford Site tank system. In FY 1999 the Characterization, Monitoring, and Sensor Technology Cross-Cutting Program and the Robotics Cross-Cut Program will support the development and design of the first prototypical analytical system. Also in FY 1999, the International Grant and TFA will support the design and fabrication of the first prototypical sampler system.

Every attempt should be made to maintain the funding profile established in this document even if the privatization schedule slips, so that the installation of the sample/analysis systems can be used earlier in the privatization schedule. The sample/analysis system demonstration schedule associated with this funding profile should be revised if the privatization schedule slips, so that the first system can be installed on a source tank that is earlier in the sequence of source tanks or, if possible, on one of the staging tanks.

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3.0 STRATEGIC ASSUMPTIONS

The strategic assumptions on which the demonstration and deployment of a nested, fixed-depth fluidics sampling and analysis system are based are provided in this section.

1. The nested, fixed-depth fluidic sampler is a suitable alternative to grab sampling and core sampling to support the staging of LAW for Phase I privatization as discussed in Claghorn et al. (1997) and Appendix D of this report.

2. Adapting the nested, fixed-depth fluidic sampler to be an alternative method to grab sampling and core sampling of Envelope D sludge, to support the staging of HLW for Phase I privatization, is a separate task, not a part of the current project. It will be considered as a later phase of the project, using technology and lessons learned from this initial project.

3. Envelope D sludge is not needed until several months after Envelopes A, B, or C material are staged and delivered.

4. Pretreatment of Envelope D sludge by enhanced sludge washing takes place in the PHMC Team's tanks before the Envelope D waste is sampled and transferred to the Privatization Contractor.

5. Adapting the nested, fixed-depth fluidic sampler system to be an alternative to grab sampling and core sampling of tank waste in the 200 West Area (e.g., in Tank 241-SY-102), to support the cross-site transfer of tank waste to the 200 East Area, is a separate task, not a part of the current project. It will be considered as a later phase of the project, using technology and lessons learned from this project.

6. The nested, fixed-depth fluidic sampling system is worthwhile, separately and apart from the at-tank analysis capability.

7. The nested, fixed-depth fluidic sampling system will be a worthwhile alternative to the baseline method when it is deployed, even if the date of deployment in support of the staging of LAW comes subsequent to the hot startup of the privatized LAW treatment and immobilization plant(s).

8. The at-tank analysis capability will be a worthwhile addition to the nested, fixed-depth fluidic sampling system when it is deployed, even if the date of deployment in support to the staging of LAW comes subsequent to the deployment of the nested, fixed-depth fluidic sampling system. The initial work on the at-tank analysis system will be funded by the Robotics Cross-Cut Program.

9. The nested, fixed-depth fluidic sampling system will use, and benefit from, the development of a fixed-depth fluidic sampling system currently underway at SRS as a Technology Deployment Initiative in FY 1998.

10. The nested, fixed-depth fluidic sampling system may be deployed first in TWRS, in a LAW feed source tank for a hot demonstration and later in units installed in the LAW feed staging tanks, 241-AP-102 and 241-AP-04. This order of demonstration and deployment may facilitate achieving hot demonstration of the nested, fixed-depth fluidic sampling system without impeding readiness of PHMC Team to support initial feed delivery to the Privatization Contractor in Phase I, Part B.

11. If the current baseline schedule of June 2002 for hot startup by the Privatization Contractor slips, then the previous assumption (assumption 8 above) should be revisited. It may become appropriate to install the sampling system first in one of the LAW feed staging tanks, 241-AP-102 or 241-AP-104, rather than in a feed source tank.

12. The at-tank analysis system will be used to expedite decision-making that a feed batch in the feed staging tank is ready to have the confirmatory samples taken for 222-S Laboratory analysis and for providing a split sample to the Privatization Contractor in accordance with the Privatization Contract. The at-tank analysis system will not perform analyses that serve as the determination for contractual purposes that the feed batch is within specification and is ready to be transferred to the Privatization Contractor's feed staging tank 241-AP-106 or 241-AP-108.

4.0 DEPLOYMENT PLAN

In FY 1998, fluidic sampler development was undertaken by AEA, incorporating its vast experience in Europe and its recent and current work on fixed-depth sampling at the SRS. Adapting this experience to the Hanford Site's LAW feed staging task includes close coordination with the PHMC staff. In parallel with this sampler development, PNNL, through the Robotics Cross-Cut Program, is working with the PHMC staff to develop analytical concepts that would be applicable for at-tank analysis in conjunction with the fluidic sampler.

A systems integration task enables the emerging sampler and at-tank analysis concepts to be coupled with the user requirements to create a Level 2 Component Specification.

4.1 DEPLOYMENT LOGIC

Figure 3 shows the deployment logic for the nested, fixed-depth LAW sampler and analysis systems. The funding amount and proposed source of funds are identified for each logic block. (In addition to supporting the development of the LAW sampler and analytical system, this Deployment Plan supports the development of the HLW sampler and analytical systems beginning in FY 2000.) A calendar (time line) is provided for the Figure 3 logic diagram to give an indication of when the funds are needed for each logic block activity. A brief description of each logic block activity follows.

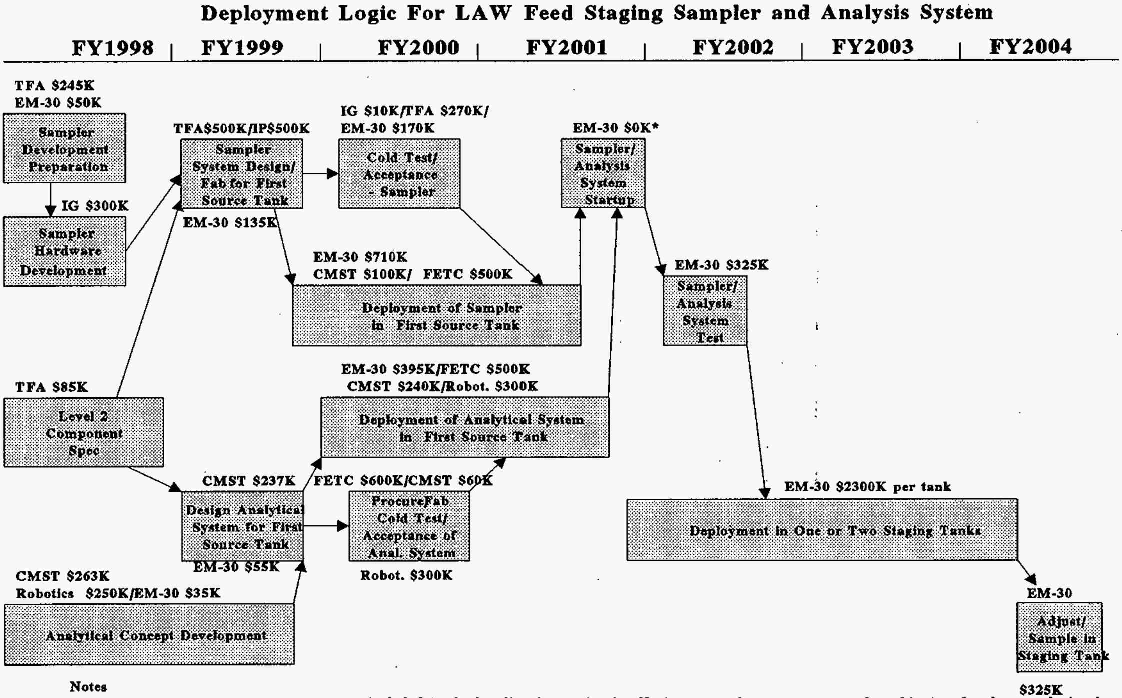
4.1.1 Sampler Development Preparation

There are two aspects to sampler development preparation at the Hanford Site in FY 1998. The first aspect is to develop a test plan and the associated Level 2 Component Specification (Functions and Requirements). The second aspect is to develop a simulant to use in running the tests at Charlotte, North Carolina, later in the fiscal year.

A test plan will be written and approved that contains the necessary test requirements to demonstrate the performance of the nested, fixed-depth fluidic sample retrieval system to meet the criteria in the Level 2 Component Specification. This test plan will include the specific simulant mixtures to be tested and criteria for verification and validation of the nested, fixed-depth fluidic sampling system. The test plan also will contain a test matrix that indicates which requirement is being demonstrated and the acceptance criteria for each test. This test plan will provide the basis for the proof-of-principle testing that will be completed at AEA.

PNNL will develop test-simulant recipes to support AEA's testing of the nested, fixed-depth fluidic sampling system concepts and prototypes. The chemical recipes will include set chemical analytes, radionuclides, and physical parameters to support the development of analysis functions and design criteria. These recipes also will be used to support the selection and validation of instrumentation for the at-tank analysis system.

Figure 3. Deployment Logic for Low-Activity Waste Feed Staging Sampler and Analysis System.



Notes
* Cost for modification during startup are included in the baseline for retrieval. No incremental costs are assumed at this time for the sampler/analyze:

4.1.2 Level 2 Component Specification

The Level 2 Component Specification (alternately known as a functions and requirements document or functional design criteria document) is needed to support the completion of hardware design, design reviews, and proof-of-principle testing of the nested, fixed-depth fluidic sampling system and to complete review of concepts identified for at-tank waste analysis. This draft document will provide the physical and chemical property range of the waste materials that must be sampled. This specification also will contain environmental and physical criteria for hardware operating inside the tank farm, criteria for in-tank operation, and criteria for using Site-approved casks to transport samples to the 222-S Laboratory and to the Privatization Contractor. The existing authorization basis will not be imposed as a requirement on the sampler. Rather, a hazards analysis and subsequent safety evaluations will be completed to determine if the existing authorization basis is adequate or will require adjustment. Any necessary adjustment in the authorization basis and update of the safety documentation will be completed as part of this deployment.

This will allow the nested, fixed-depth fluidic sample retrieval system to operate reliably and relatively maintenance free through a "12-in." riser of the Hanford Site tanks. Waste samples will be provided to the Privatization Contractor and to the 222-S Laboratory for analysis.

4.1.3 Sampler Hardware Development

In FY 1998, the EM-50 International Grants funded AEA to implement the project technical plan, *Design and Demonstration of a Nested Array of Fluidic Samplers*, PTP Number: TFA/PF/17/v2, April 1998 (Murray et al. 1998). The scope of this effort is represented by the logic block, "Sampler Hardware Development," in Figure 3 and consists of the following tasks:

- Orientation of the PHMC Team with the AEA design approach;
- Development of alternative variable-depth sampler design concepts;
- Meeting with PHMC Team to discuss and select the variable-depth sampler design concept to be pursued (a nested, fixed-depth concept was selected, Milestone 98-01);
- Design of a fluidic system to sample the Hanford Site tank waste at multiple depths;
- Overview design of the sampling station;
- Fabrication of a test rig at AEA facilities in Charlotte, North Carolina, to demonstrate the repeatability and reliability of the samples taken from the tank;
- Evaluation of structural forces on the sampler in the tank;
- Evaluation of deployment method for the unit;

- Conceptual design drawing of the unit;
- Set of trials on the test unit using three surrogate sludges defined by PNNL;
- Trials to demonstrate the behavior of the sampler pump in a salt tank environment, investigating the pump's ability to recover from a salt cake "blockage;"
- Investigation into the cross-contamination of samples resulting from the valving arrangement being designed to connect the sampler pumps to a common sample need;
- Demonstration of the test unit to Hanford Site engineers;
- A report on life-cycle cost analysis of the proposed sampler; and
- A final report detailing the performance of the system and the data obtained.

4.1.4 Sampler System Design/Fabrication of Equipment for the First Source Tank Selected for Deployment

The design and the fabrication of the nested, fixed-depth fluidic sampler and the tank interface equipment needed to deploy the sampler on the first source (or feed-staging) tank selected will be completed. The design will be a two-step design process in which an initial conceptual design is completed first, followed by a formal design. The design will identify the necessary tank farm interfaces as well as the proposed cask and sample transport systems required to ship the sample to a laboratory for analysis. A final design review will be completed before procurement and fabrication are initiated.

4.1.5 Cold Testing/Acceptance of the Sampler

In this task, a Hanford Site facility will be identified where the cold testing can be completed with the nested, fixed-depth fluidic sampling system hardware. Preparations and modifications that are needed to accommodate the installation of the nested, fixed-depth sampling system hardware will be completed. Hardware checkout and acceptance testing will be completed as the nested, fixed-depth sampling system hardware and the tank interface hardware are received and set up. Functional (cold) testing will be completed using a matrix of waste simulants that covers the expected range of material characteristics for waste Envelopes A, B, and C. The lessons learned from the checkout of the nested, fixed-depth sampling system hardware and the results of the functional testing will be incorporated into the nested, fixed-depth sampling system design. Modifications then will be made to the hardware where deemed necessary to meet performance criteria identified in the Level 2 Component Specification document.

4.1.6 Deployment of Sampler in the First Source

Tank Selected for Deployment

This task includes in-tank deployment documentation, the operational test procedure, readiness review, and installation in the first source tank. The in-tank deployment documentation will contain environmental documentation, safety documentation, and system operating procedures. The operational test procedure will verify the operations of the integrated system in a cold environment. Operators will be trained during these tests. The readiness review will include both a contractor and a DOE review.

4.1.7 Analytical Concept Development

In FY 1998, the EM-50 Robotics Technology Development Cross-Cut Program funded PNNL to implement the technical task plan, "Robotics Tank Waste." The scope of this effort is represented by the logic block, "Analytical Concept Development," in Figure 3 and consists of the following tasks in FY 1998:

- Closely work with the TFA-funded effort that identifies Milestone 98-2, a preliminary set of physical and chemical parameters to monitor at waste feed staging tanks;
- Prepare functions and requirements for the at-tank analytical instruments, based on the chemical, physical, and radiological species to be measured;
- Complete a preliminary conceptual design of the at-tank analysis system;
- Test and demonstrate selected analytical instruments and measurement concepts and complete tests (using simulants representative of the waste constituents expected to be found in waste Envelopes A, B, and C) to identify measurement accuracy, sensitivity, and precision.

4.1.8 Design of the Analytical System

The design of the analytical system needed to deploy the system on the first source tank selected will be completed. The design will be a two-step design process in which an initial conceptual design is completed first, followed by a definitive design. A final design review will be completed before procurement and fabrication are initiated.

4.1.9 Procurement/Fabrication/Cold Test/Acceptance of an Analytical System for the First Source Selected for Deployment

The procurement and fabrication of an at-tank analysis system will be completed in this task. Acceptance checkout and testing will be completed when the fabrication is completed. Checkout lists will be prepared and equipment will be examined to ensure conformation with design parameters and specifications. A location will be identified at the Hanford Site at which cold tests can be completed for the at-tank analysis system. Facility preparations will be completed, and the at-tank analysis system hardware will be installed. Hardware checkout and acceptance testing will proceed as the hardware is set up. Functional and performance testing will be completed. Cold testing will be completed using a matrix of waste simulants that covers the expected range of material characteristics for waste Envelopes A, B, and C. The lessons learned from the checkout of the at-tank analysis system hardware and the results of the cold testing will be incorporated into design revisions for the systems design. Modifications then will be made to the hardware where deemed necessary to meet performance criteria identified in the Level 2 Component Specification document.

4.1.10 Deployment of Analytical System in the First Source Tank Selected for Deployment

This task includes in-tank deployment documentation, the operational test procedure, readiness review, and installation in the first source tank. The in-tank deployment documentation will contain environmental documentation, safety documentation, and system operating procedures. The operational test procedure will verify the operations of the integrated system in a cold environment. Operators will be trained. The readiness review will include both a contractor and a DOE review.

4.1.11 Retrieval/Sample and Analysis Systems Startup for First Source Tank

The Retrieval/Sample and Analysis Startup task includes making any modifications of either the retrieval system or the sample and analysis system that the contractor readiness review identifies for a retrieval system of the first source tank in which the sample and analysis system is deployed. The modifications could include those associated with hardware or with documentation.

4.1.12 Sampler/Analysis System Test

A hot test of the sampler/analysis system will be conducted. The mixer pumps will be running while the samples are taken and analysis is performed. At-tank analysis will be compared with the 222-S Laboratory analysis.

4.1.13 Deployment in Staging Tanks

This task includes system design of the sampling and analysis system, fabrication, in-tank deployment documentation, the operational test procedure, readiness review, and installation in LAW feed staging tanks 241-AP-102 and 241-AP-104. The design will include both a conceptual and definitive design. The in-tank deployment documentation will contain environmental documentation, safety documentation, and system operating procedures. The operational test procedure will verify the operations of the integrated system in a cold environment. Operators will be trained during these tests. The readiness review will include both a contractor and a DOE review.

4.1.14 Adjust/Sample in Staging Tank

The sampler/analytical system will be used during sampling and adjusting of the waste that has been transferred to the staging tank from a source tank. The system will be used for process control (1) to determine when a confirmatory sample should be taken before transfer and (2) to actually take this confirmatory sample.

4.2 PLANNING ASSUMPTIONS

The planning assumptions on which the demonstration and deployment of a nested, fixed-depth fluidics sampling and analysis system are based are provided in this section (Baldwin 1998).

1. LAW feed will be staged by the PHMC Team in Tanks 241-AP-102 and 241-AP-104.

2. Privatized hot operations are assumed to start in June 2002 and end in May 2011.

3. Privatization Contractor samples will be required in addition to those needed to meet the PHMC Team requirements.

4. A few liters of samples will be required to satisfy PHMC Team and Privatization Contractor needs.

5. Large mixer pumps will be installed in the feed staging tanks.

6. The facility processing rates for each facility during Phase I is 2.0 metric tons of sodium per day (LAW) for both privatization contractors.

7. There is no radial (i.e., horizontal) variability in the waste composition, because of the operation of the mixer pumps in the feed staging tank; therefore, sampling at a single riser location is adequate.

8. The vertical variability of the waste as measured by the sampling system at multiple depths does not change significantly during the time that is required to take the full set of nested, fixed-depth samples.

9. The new sampling and analysis approach will have the benefits described in Section 1.1.2.

4.3 DEVELOPMENT AND DEPLOYMENT SCHEDULE

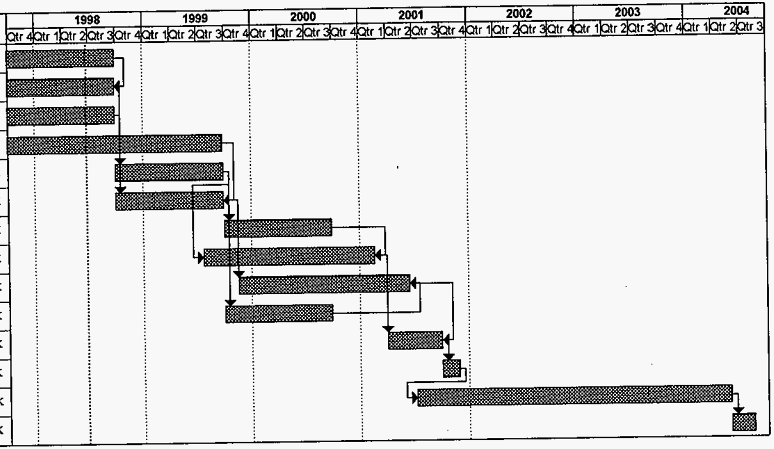
The deployment schedule for the nested, fixed-depth sampler and analytical systems is shown in Figure 4. It is a relatively high-level schedule. A more detailed schedule of the first demonstration is contained in HNF-2056, *Engineering Task Plan For Development, Fabrication, and Deployment of Nested, Fixed-Depth Fluidic Sampling and At-Tank Analysis Systems* (Reich and Smalley 1998). The schedule assumes that the overall privatization processing schedule is consistent with the baseline schedule contained in HNF-1946, *TWRS Retrieval and Disposal Mission Initial Updated Baseline Summary* (Swita et al. 1998). Thus the first tank selected for implementation will not be 241-AP-102 or 241-AP-104 because the sampler/analytical system development schedule would not be consistent with the baseline privatization processing schedule. Instead, Tank 241-AN-104, a source tank, was selected. The sampler and analytical systems will be able to be used on the preparation for the removal of the second half of waste from Tank 241-AN-104, assuming the current baseline schedule. If the baseline privatization processing schedule is delayed 16 months, the first tank selected for implementation would be 241-AP-102 or 241-AP-104.

4.4 DEVELOPMENT AND DEPLOYMENT COSTS

The development costs include: the cost to design, build, and test the concept of the nested, fixed-depth sampler; the cost to design, build, and both cold- and hot-test the nested, fixed-depth prototypical sampler system; the cost to design, build, and test concepts for the at-tank analysis system; and the cost to design, build, and both cold- and hot-test the prototypical analytical system. The total developmental cost is estimated to be about $7.6 million (the total project costs through FY 2001 plus $325,000 in FY 2002 for sampler/analysis system test). These costs are identified in Figure 3. A more detailed cost estimate of the development of the first prototypical system is contained in HNF-2056 (Reich and Smalley 1998).

Figure 4. Deployment Schedule for the Nested, Fixed-depth Fluidic Sampler and Analysis System.

ID	Task Name	Duration
1	Sampler Development Preparation	37 wk
2	Sampler Hardware Development	37 wk
3	Level 2 Component Spec	37 wk
4	Analytical Concept Development	74 wk
5	Sampler Sys Design/Fab for 104-AN	37 wk
6	Design Analytical System for 104-AN	37 wk
7	Cold Test/Acceptance - Sampler	37 wk
8	Deployment of Sampler in 104-AN	59 wk
9	Deployment of Anal Sys in 104-AN	59 wk
10	Proc/Fab/Cold Test/Accept of Anal Sys	37 wk
11	Sampler/Analytical System Startup	19 wk
12	Sampler/Analytical System Test	6 wk
13	Deployment in Two Staging Tanks	108 wk
14	Adjust/Sample in Staging Tk (102-AP)	8 wk



The cost for deployment of the LAW sampling and analysis system was estimated to be \$2.3 million per tank plus \$325,000 in FY 2004 for adjustment/sampling in the staging tank. The cost of the system was based on the cost to develop Level 2 specifications and to design, build, and test the hot system. These costs are detailed in Appendix C. Two systems were assumed to be installed—one for each LAW feed staging tank; therefore, the total estimated deployment cost is \$4.9 million. This estimate is consistent with a baseline of two staging tanks and two privatization contractors. It also is consistent with using two staging tanks for one privatization contractor for Envelopes A and C and taking grab samples and doing laboratory analysis for the returned pretreated Envelope B waste, which is consistent with the recent 05/27/98 Readiness-To-Proceed Alternate Case.

The incremental development costs to add the HLW sampling and at-tank analysis capability were estimated to be \$1.09 million, as noted at the bottom of the table in Appendix C, Section C.2. The costs for deployment of an HLW sampling and analysis systems were estimated to be \$4.9 million. This is based on the installation of two systems and the running of one sampler/analysis test. In the baseline, the first tank (241-AZ-101) would be transferred before these systems were installed and, therefore, only two systems were assumed (tanks 241-AZ-102 and 241-AY-102). In the recent 05/27/98 Readiness-To-Proceed Alternate Case, the HLW transfers would occur before the LAW transfers but would be delayed more than two years. In this case, however, all of the waste is being staged through Tanks 241-AZ-101 and 241-AZ-102. Therefore, only two systems are needed in this Alternate Case as well.

4.5 PROJECT TEAM

The Nested, Fixed-Depth Sampler and Analysis System Team includes the key staff of the various supporting programs as well as the implementing organizations. The responsibilities are assigned to various companies and organizations as identified in the following.

Representatives of the TFA will provide an interface to the TFA Technical Management Team to ensure that the project is implemented in a manner consistent with TFA planning and programmatic goals. Lockheed Idaho Technologies Company will provide the Technical Integration Manager, who will be the point of contact for technical direction of the work scope. PNNL will provide the Technology Delivery Manager , who will support the Technical Integration Manager in tracking performance on key deliverables and resolution of technology deployment issues.

Responsible Technical Integration Manager	TR Thomas
Responsible Technology Delivery Manager	BA Carteret

Representatives of the Characterization, Monitoring, and Sensor Technology Cross-Cut Program will provide an interface to the Characterization, Monitoring, and Sensor Technology Technical Management Team to ensure that the project is implemented in a manner consistent with TFA planning and programmatic goals.

Responsible Point of Contact	GJ Bastiaans (Ames Lab, Iowa State University)

The Fluor Daniel Hanford, Inc., Technology Management Office is the programmatic point of contact for the EM-50 programs such as the TFA. Fluor Daniel Hanford, Inc., will provide Site administration and reporting for this program.

Responsible Manager	GT Berlin
Responsible Point of Contact	SK Foreman

The Lockheed Martin Hanford Corporation Integrated Process/Product Teams group with TWRS Planning and Integration will provide funding and program oversight as well as technical support in review and approval of planning and criteria documentation.

Program Manager/Principal Investigator	KA Gasper
Responsible Engineer	JN Appel
Responsible Budget Analyst	PR Weinman

The Lockheed Martin Hanford Corporation Characterization Engineering group will provide project oversight as well as technical leadership and support in the development, review, and approval of design criteria, Site safety, and operational documentation. Characterization Engineering also will provide the cognizant engineering and design authority function.

Characterization Engineering	RM Boger (Numatec Hanford Corporation)
Design Authority	GP Janicek
Cognizant Manager	JS Schofield
Cognizant Engineer	RG Brown

The Lockheed Martin Hanford Corporation Data Assessment and Interpretation group will provide support in the development and approval of criteria and test simulant documentation.

Cognizant Manager	KM Hall
Tank Waste Characterization	J Jo

Lockheed Martin Hanford Corporation Characterization Project Operations also will provide safety, quality, environmental, and operations reviews of documentation as required to support this activity.

Responsible Manager	RS Popielarczyk
Safety Engineer	JA Ranschau
Quality Assurance Engineer	ML McElroy
Environmental Engineer	DL Dyekman

DE&S Hanford, Inc. will provide authorization-basis analysis support including unreviewed safety question screenings.

Responsible Manager	CE Leach
Responsible Engineer	TG Goetz

COGEMA Engineering Corporation will provide engineering services for managing the tasks associated with this project and engineering support during AEA's design and test of the prototype nested, fixed-depth fluidic sampling system. COGEMA Engineering Corporation will prepare documentation as specified in the Engineering Task Plan for review and issuance.

Responsible Manager	CE Hanson
Responsible Engineer	JD Criddle
Responsible Engineer	FR Reich
Responsible Engineer	JL Smalley

PNNL will perform development of test simulant criteria and will provide support in the development and review of criteria and testing documents. PNNL also will provide project reporting for these tasks.

Responsible Engineer	MW Rinker
Responsible Engineer	MR Powell

PNNL also will provide support to this project through the Robotics Cross-Cut Program for the at-tank analysis portion of the overall system.

Responsible Robotics Program Point of Contact	SA Bailey
Responsible Engineer/Principal Investigator	MG Dodson

AEA will perform the necessary design and proof-of-principle testing of the nested, fixed-depth sampler system.

Responsible Point of Contact	Paul Murray

5.0 RETURN ON INVESTMENT

Three different calculations of the return on investment were made for three different cases. These are contained in Appendix B, Section B.4. All calculations are based on the reduction in risk divided by the cost to develop and deploy the systems. Risk reduction was based on the difference in the product of the most likely consequent and likelihood. The first calculation assumed that both LAW and HLW sampler and analysis systems were implemented. The results indicated a return on investment of about 2.4. The second calculation assumed that only LAW sampler and analysis systems were implemented. This was calculated because it might be a reasonable stopping point in the deployment. The results indicated a return on investment of about 2.7. The third calculation assumed that the HLW sampler and analysis systems were installed and used only the incremental cost and risk reduction associated with the development and deployment of the HLW systems. Thus, the return on investment was an incremental one that took advantage of what was learned in the development and deployment of the LAW systems. The results of this case indicated a return on investment of 1.7.

In addition to these three calculations, a more rigorous solution using Monte Carlo techniques was completed for the risk reduction. Using a typical value generated from probability curves for risk reduction, a return on investment of 2.8 was calculated for the LAW and HLW systems. This more rigorous approach will be used more extensively in future updates of the Deployment Strategy and Plan when the raw data are of higher quality.

All risk likelihood and consequence numbers used in this version of the plan are preliminary; they were not reviewed by technical staff or management in the context of the ongoing risk management activities. Therefore, while the numbers reflect the best estimates of the authors of this document, they are likely to change in the future. All of the digits have been retained in the cost estimates to ensure traceability throughout the document and to supporting documentation. In fact, these numbers are only preliminary planning numbers and, as such, have an uncertainty of perhaps 25% or more.

While the absolute numbers are not highly accurate because the project is in the early stages of development, there does appear to be a difference between the return on investment for LAW and the increment for HLW. For implementation of only the LAW sampling and analysis system, the full LAW feed staging tank sampler development costs are used in the calculation. For implementation of the HLW sampling and analysis system, the incremental development and deployment costs are used. That is, the development of the HLW systems takes advantage of what was learned from the LAW systems development. If only the HLW were implemented, the return on investment would be significantly lower, and pursuing that option is not recommended. This is particularly important in light of the 5/27/98 RTP Alternate Case that was provided to the PHMC Team by DOE and is believed to be close to how the contract will be revised in the authorization to proceed. In this case, HLW pretreatment and vitrification would precede LAW treatment by a couple years. Thus, the HLW sampler and analysis system would be needed before the LAW.

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6.0 REFERENCES

Baldwin, J. H. , 1998, *Tank Waste Remediation System Retrieval and Disposal Mission Key Enabling Assumptions*, HNF-1945, Rev. 1, prepared by Lockheed Martin Hanford Corporation for Fluor Daniel Hanford, Inc., Richland Washington.

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APPENDIX A

COMPARISON OF OPERATIONAL LOGICS AND SCHEDULES

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APPENDIX A

COMPARISON OF OPERATIONAL LOGICS AND SCHEDULES

A.1 OPERATION LOGIC USING GRAB SAMPLES AND LABORATORY ANALYSIS (WITHOUT AT-TANK ANALYSIS)

Figure A-1 shows the operational logic diagram for the existing sampling and analysis approach. Below is a brief description of each logic block activity.

Receive Waste/Water from Source Tank

The first half of a double-shell slurry feed waste tank will be decanted and diluted with water as it is transferred from the source tank to the staging tank. The second half of a double-shell slurry feed waste tank will be diluted, mixed, settled, and then decanted from the source tank to the staging tank.

Mix Waste in Tanks 241-AP-102 and 241-AP-104

The waste is planned to be mixed in the staging tank with one mixer pump for a period of time.

Take Samples in Tanks 241-AP-102 and -104

Grab samples of approximately 100 mL will be taken from the staging tank. The purpose is to confirm that the tank is well mixed. For planning purposes, it is assumed that the samples will be taken at three depths through one riser. Future operational experience and statistical analysis will be used to refine this assumption.

Transport Samples

The samples will be placed in shielding pigs and transported to the laboratory via truck.

Analyze Sample

The samples will be removed from the shielding pigs, prepared as required, and analyzed. For planning purposes it is assumed that the analyses include inductively coupled plasma spectrometer analysis of the filtrate, bulk density, pH, and percent solids. Future operation experience and contract negotiations will be used to refine this assumption.

Evaluate Sample Data

This evaluation will determine if most of the soluble solids have dissolved, if the tank is well mixed, and if the combined feed is likely to be within specification.

Figure A-1. Staging Tank Operational Logic Without At-Tank Analysis. (3 sheets)

Staging Tank Operational Logic Without At Tank Analysis

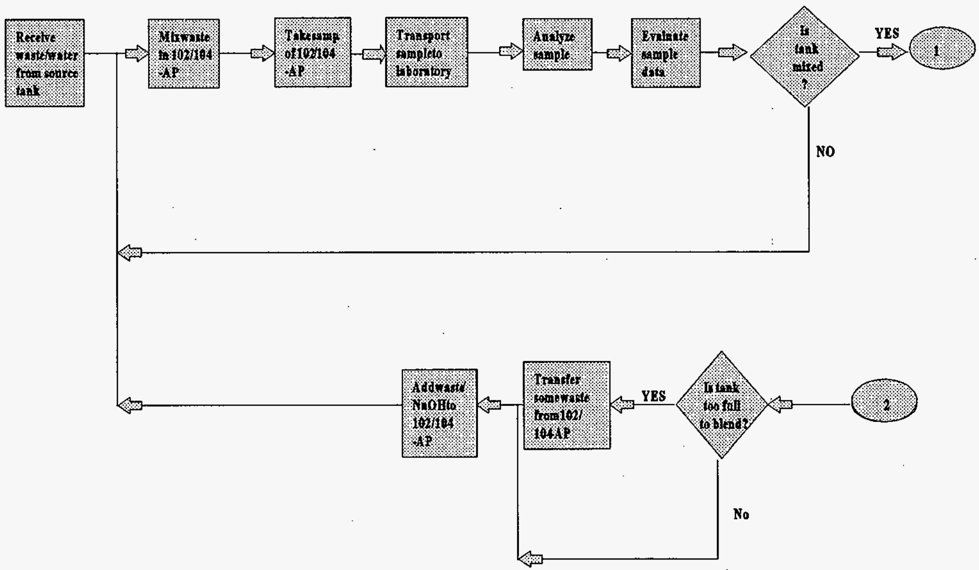
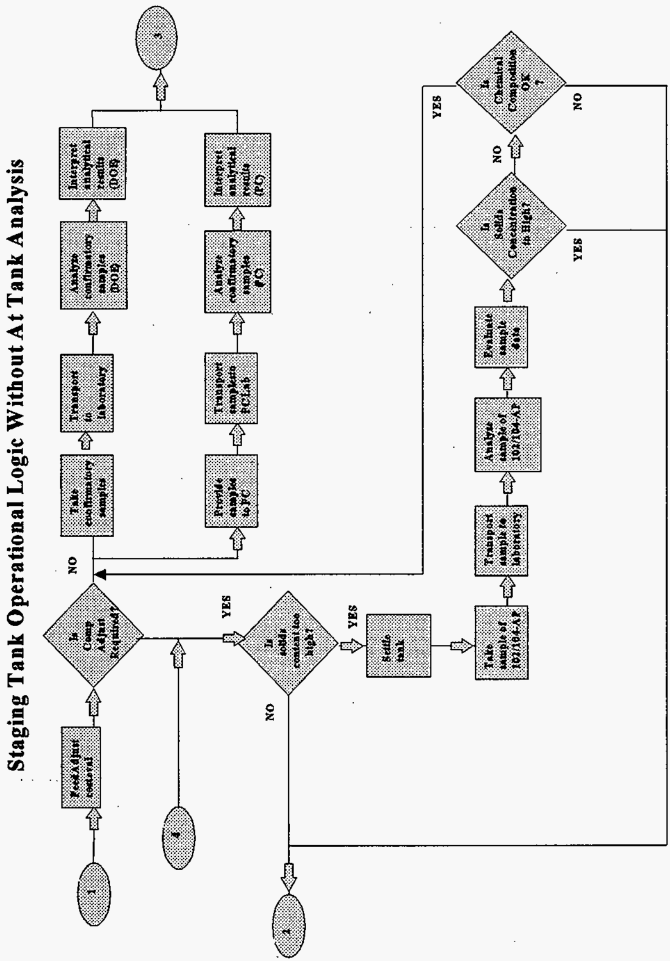


Figure A-1. Staging Tank Operational Logic Without At-Tank Analysis. (3 sheets)



Staging Tank Operational Logic Without At Tank Analysis

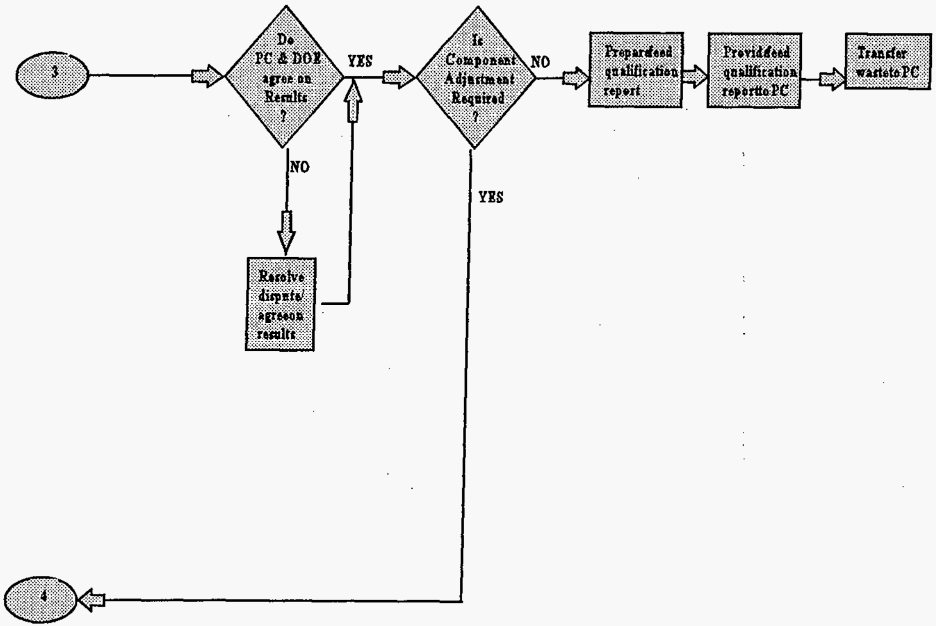


Figure A-1. Staging Tank Operational Logic Without At-Tank Analysis. (3 sheets)

Perform Feed Adjust Cost Evaluation

If the feed is not likely to be within specification, a cost evaluation will be performed. This evaluation will compare the cost of adjusting the feed for various adjustment scenarios, blending or potentially accepting an increased payment to the Privatization Contractor based on some formula negotiated in the contract.

Take Confirmatory Samples

If the composition is not likely to require adjustment or it is not cost effective to adjust/blend, samples will be taken to confirm that the composition is acceptable. The number of grab samples from each tank will range from 3 to 19, depending on the feed batch. The proposed number of samples for each batch are given in *Alternative Generation and Analysis for the Phase I Intermediate Waste Feed Staging System Design Requirements* (Claghorn et al. 1997). Further details regarding feed qualification sampling requirements will be developed by the U.S. Department of Energy (DOE) and included in the contract.

Transport to Laboratory

The confirmatory samples will be placed in casks and transported to the DOE laboratory (assumed to be 222-S Laboratory) via truck.

Analyze Confirmatory Samples (DOE)

The samples will be removed from the casks, prepared as required, and analyzed. The proposed analyses are given in Claghorn et al. (1997). These analyses will be revised as needed based on revisions to the contracts with the Privatization Contractor.

Interpret Analytical Results (DOE)

The sample results will be compared against the envelope specifications contained in the contract.

Provide Samples to the Privatization Contractor

A 1-liter sample will be provided to the Privatization Contractor for their analytical confirmation.

Transport Samples to the Privatization Contractor's Laboratory

The confirmatory samples will be placed in casks and transported to the Privatization Contractor's laboratory via a mode chosen by the Privatization Contractor.

Analyze Confirmatory Samples (Privatization Contractor)

If the Privatization Contractor chooses, the samples will be removed from the casks, prepared as required, and analyzed as determined by the Privatization Contractor.

Interpret Analytical Results (Privatization Contractor)

If the Privatization Contractor chooses, the sample results will be compared against the envelope specifications.

Resolve Dispute/Agree on Results

If a dispute over the analytical results occurs, the dispute resolution procedure contained in the contract will be followed.

Prepare Feed Qualification Report

A feed qualification report will be prepared in accordance with the privatization contract.

Provide Feed Qualification Report to Privatization Contractor

This activity is the official transmittal of the feed data to the Privatization Contractor.

Transfer Waste to Privatization Contractor

The waste will be transfer to the Privatization Contractor's feed tanks (241-AP-106 and 241-AP-108) via pipeline.

Transfer Waste from Tanks 241-AP-102 and 241-AP-104

If the staging tank requires some adjustment and is too full of waste to blend or add chemicals, then some or all of the waste will be transferred from the staging tank back to a tank in the tank farms. The tank to which it will be transferred will depend on the amount and the composition of the waste.

Add Waste/NaOH to Tanks 241-AP-102 and 241-AP-104

The staging waste will be blended by transferring waste from a source tank to the staging tank. Water or chemicals will be added as necessary to meet the feed specification.

Settle Waste

If required, the waste in the staging tank will be settled to reduce the solids concentration in the liquid.

A.2 OPERATIONAL LOGIC USING NESTED, FIXED-DEPTH SAMPLER

Figure A-2 shows the operational logic diagram for the new sampling and analysis approach. The logic blocks are essentially the same except that the samples will not be dip samples and will not be transported to the laboratory unless they are the confirmatory samples.

A.3 COMPARISON OF OPERATING SCHEDULES

To demonstrate the potential time savings associated with using the nested, fixed-depth sampler and at-tank analysis over the grab sample and 222-S Laboratory, a schedule was prepared for an assumed path through the logic. The assumed logic path is as follows:

- The tank is mixed, sampled, and found to be inadequately mixed
- It is mixed again and sampled again
- After the second mixing period, it is discovered that the solids content appears too high
- The tank is allowed to settle
- After allowing about two weeks to settle, a sample is taken and the concentration of solids is still too high
- Chemicals are added to reduce the solids concentration
- The tank is mixed and sampled again
- Both the chemical and physical specifications are met, and the confirmatory samples are taken
- The analysis of the confirmatory samples agrees with the preliminary indication; the feed qualification report is prepared, and the feed is transferred.

The schedule using grab samples and the 222-S Laboratory is shown in Figure A-3. Each time samples are taken, it takes about 1 day to get the samples to the 222-S Laboratory. Preliminary analyses are completed in about 14 days. Confirmatory samples are completed in about 60 days. The estimated time to complete this schedule is 186 days. If there were any bad-weather delays, the schedule would be correspondingly longer.

Staging Tank Operation Logic With At Tank Analysis

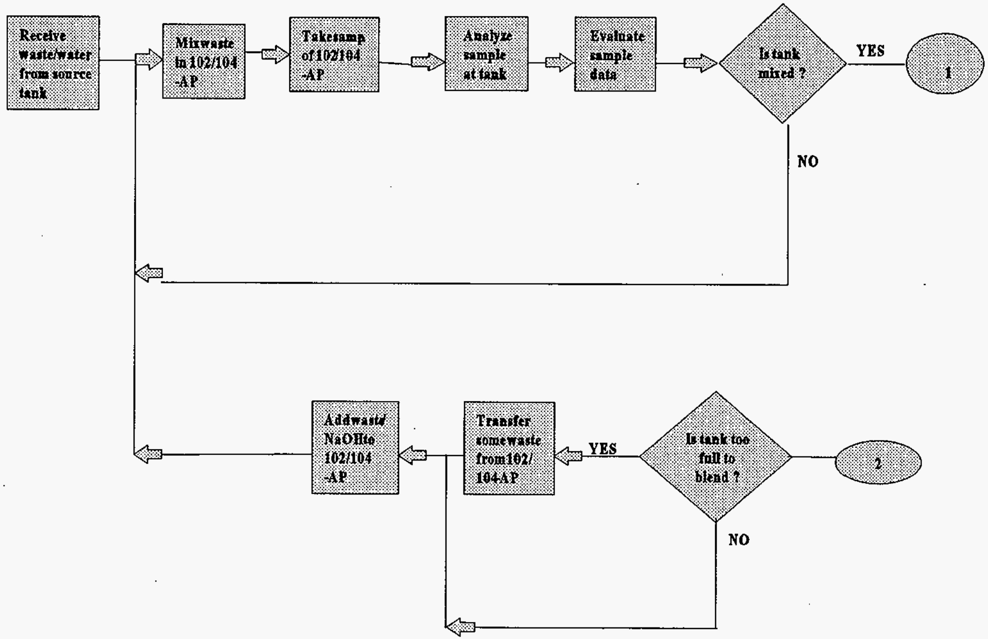
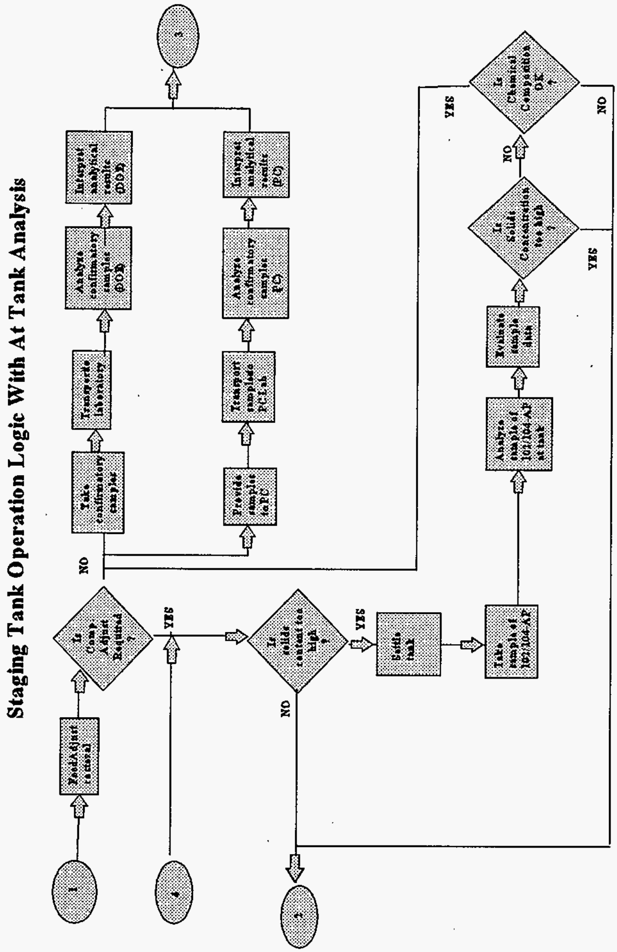


Figure A-2. Staging Tank Operation Logic With At-Tank Analysis. (3 sheets)

Figure A-2. Staging Tank Operation Logic With At-Tank Analysis. (3 sheets)



Staging Tank Operational Logic With At Tank Analysis

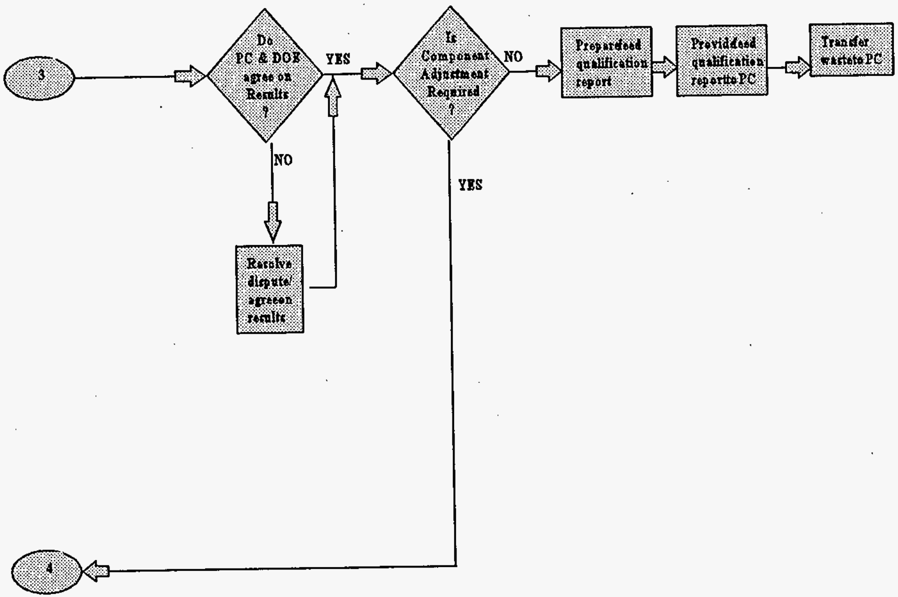


Figure A-2. Staging Tank Operational Logic With At-Tank Analysis. (3 sheets)

The schedule using the nested, fixed-depth sampler and at-tank analysis is shown in Figure A-4. For this schedule, it is assumed that the preliminary analyses that check mixing (a simple chemical constituent such as sodium) or settling (percent solids) is completed on the same day that the sample is taken. For preliminary analyses after chemical adjustment, it is assumed that the samples would require an inductively coupled plasma spectrometer analysis and therefore would be transported to the 222-S Laboratory (taking about 1 day) and analyzed (taking about 14 days). Again, the confirmatory analyses require about 60 days. The estimated time to complete the schedule using the nested, fixed-depth sampler is 141 days or about 45 days less than the schedule developed using grab samples. Bad weather is unlikely to cause any lengthening of this schedule.

A.4 REFERENCE

R. D. Claghorn, J. D. Galbraith, and T. B. Salzano, 1997, *Alternatives Generation and Analysis for the Phase I Intermediate Waste Feed Staging System Design Requirements*, HNF-SD-TWR-AGA-001, Rev. 1, prepared by Numatec Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Figure A-3. Staging Tank Operation Schedule Using Grab Samples.

ID	Task Name	Duration
1	Mix waste in 102/104-AP	7 days
2	Take sample of 102/104-AP	1 day
3	Transport sample to lab	1 day
4	Analyze sample	14 days
5	Evaluate sample data	1 day
6	Mix waste in 102/104-AP	7 days
7	Take sample of 102/104-AP	1 day
8	Transport sample to lab	1 day
9	Analyze sample	14 days
10	Evaluate sample data	1 day
11	Feed Adjust Cost Evaluation	1 day
12	Settle tank	15 days
13	Take sample of 102/104-AP	1 day
14	Transport sample to lab	1 day
15	Analyze sample	14 days
16	Evaluate sample data	1 day
17	Add NaOH to 102/104-AP	2 days
18	Mix waste in 102/104-AP	7 days
19	Take sample of 102/104-AP	1 day
20	Transport sample to lab	1 day
21	Analyze sample	14 days
22	Evaluate sample results	1 day
23	Take confirmatory sample	1 day
24	Transport sample to lab	1 day
25	Analyze confirmatory sample	60 days
26	Interpret analytical results	7 days
27	Prepare feed qual. report	7 days
28	Provide feed qual. rep to PC	1 day
29	Transfer waste to PC	2 days

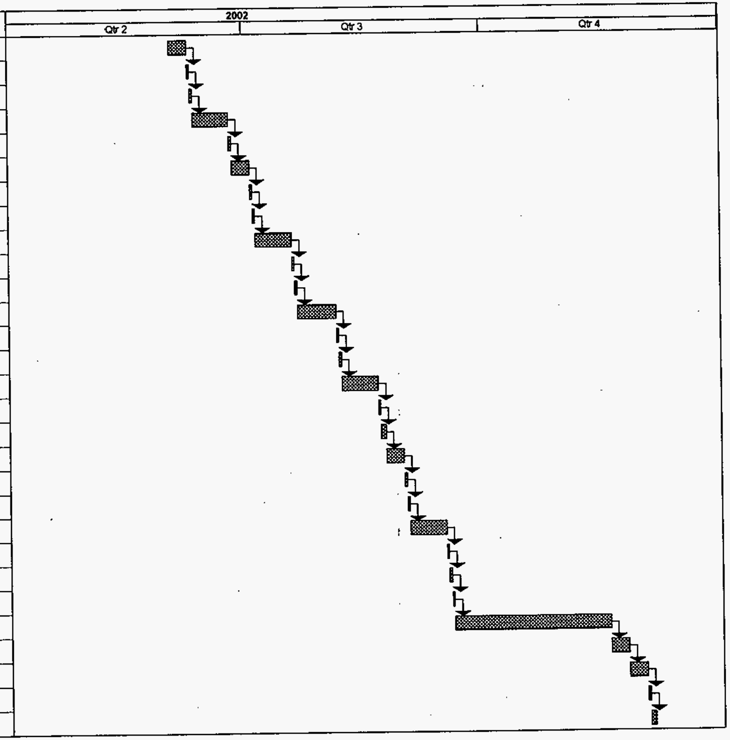
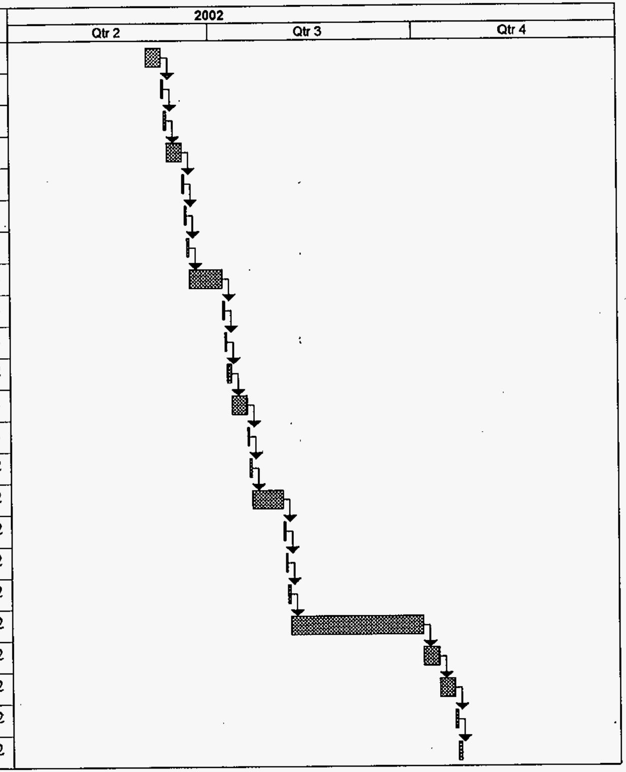


Figure A-4. Staging Tank Operation Schedule Using Nested, Fixed-depth Fluidic Sampler.

ID	Task Name	Duration	Start
1	Mix waste in 102/104-AP	7 days	Mon 6/3/02
2	Take sample of 102/104-AP	1 day	Mon 6/10/02
3	Evaluate sample data	1 day	Tue 6/11/02
4	Mix waste in 102/104-AP	7 days	Wed 6/12/02
5	Take sample of 102/104-AP	1 day	Wed 6/19/02
6	Evaluate sample data	1 day	Thu 6/20/02
7	Feed Adjust Cost Evaluation	1 day	Fri 6/21/02
8	Settle tank	15 days	Sat 6/22/02
9	Take sample of 102/104-AP	1 day	Sun 7/7/02
10	Evaluate sample data	1 day	Mon 7/8/02
11	Add NaOH to 102/104-AP	2 days	Tue 7/9/02
12	Mix waste in 102/104-AP	7 days	Thu 7/11/02
13	Take sample of 102/104-AP	1 day	Thu 7/18/02
14	Transport sample to lab	1 day	Fri 7/19/02
15	Analyze sample	14 days	Sat 7/20/02
16	Evaluate sample results	1 day	Sat 8/3/02
17	Take confirmatory sample	1 day	Sun 8/4/02
18	Transport sample to lab	1 day	Mon 8/5/02
19	Analyze confirmatory sample	60 days	Tue 8/6/02
20	Interpret analytical results	7 days	Sat 10/5/02
21	Prepare feed qual. report	7 days	Sat 10/12/02
22	Provide feed qual. rep to PC	1 day	Sat 10/19/02
23	Transfer waste to PC	2 days	Sun 10/20/02



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APPENDIX B

OPERATING SCENARIO RISK ANALYSIS

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APPENDIX B

OPERATING SCENARIO RISK ANALYSIS

The risks that are addressed by the power fluidic sampler and at-tank analysis system are contained within the *Tank Waste Remediation System Retrieval and Disposal Mission Critical Risk List*, Attachment 5 of HNF-2019, Rev. 1 (Jordan 1998), and the associated lower-level project level risk lists such as the Waste Feed Delivery Risk List.

B.1 CRITICAL RISKS

B.1.1 Critical Risk 9—"Facility Processing Rates"

The risk is that the U.S. Department of Energy (DOE) may contract with the Privatization Contractor for a higher feed rate than the Tank Waste Remediation System (TWRS) Project Contractor can initially deliver. This could cause DOE to pay penalties to the Privatization Contractor for idle facilities. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Mini-mum	Most likely	Maxi-mum	Minimum	Most likely	Maximum	
Initial (Baseline)	0%	15%	50%	$0	$98 million (0 wk the first yr; 2 wk the second yr; 4 wk the third through fifth yr, @ $1 million/day; over 5 yr = $98 million)	$112 million (0 wk the first yr; 4 wk the second through fifth yr @ $1 million/day; over 5 yr = $112 million)	$14.7 million
Residual (with fluidic sampler)	0%	15%	50%	$0	$42 million (0 wk the first yr; 0 wk the second yr; 2 wk the third through fifth yr @ $1 million/day; over 5 yr = $42 million)	$56 million (0 wk the first yr; 2 wk the second through fifth yr @ $1 million/day; over 5 yr = $56 million)	$6.3 million

*Most Likely Likelihood times Most Likely Consequence.

All risk likelihood and consequence numbers used in this version of the plan are preliminary, not reviewed by technical staff or management in the context of the ongoing risk management activities. Therefore, while they reflect the best estimates of the authors of this document, they are likely to change in the future.

By using a nested, fixed-depth sampler and at-tank analysis system for process control, the time to obtain and analyze process control samples will be reduced. With a smaller time for sampling and analysis, the rate at which feed can be staged for delivery to the Privatization Contractor will be increased. Thus the risk of DOE not meeting the contractual processing rate will be decreased.

B.1.2 Critical Risk 22—"Waste Feed Is Out-of-Specification"

The risk is that waste feed may not meet Phase I specifications and will require unplanned adjustments. These unplanned adjustments will decrease the feed staging rate and could cause DOE to pay penalties to the Privatization Contractor for idle facilities. Additional costs, including additional costs for sampling and analysis, also will be incurred for adjusting the waste. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Mini-mum	Most likely	Maxi-mum	Minimum	Most likely	Maximum	
Initial (Baseline)	80% chance that it will happen once	90% chance that it will happen once	100% chance that it will happen once	15 days; consequence will depend on available float: could be $1 million/day; $0	45 days; consequence will depend on available float: could be $1 million/day; Estimate: 30 days float and 15 days impact = $15 million	60 days; consequence will depend on available float: could be $1 million/day = $60 million	$13.5 million
Residual (with fluidic sampler)	80%	90%	100%	0 (float will accommodate)	0 (float will accommodate)	0 (float will accommodate)	$0

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	20%	50%	80%	$300,000 (1 additional time of taking a grab sample and getting it analyzed at 222-S; if DOE negotiates a reasonable compensation model for out-of-specification feed)	6 repeats of $300,000 each = $1.8 million (6 additional times of taking a grab sample and getting it analyzed at 222-S @ $300,000; if DOE negotiates a reasonable compensation model for out-of-specification feed)	6 repeats at $1 million each = $6 million. (if DOE needs to restage or if feed adjustments cause lack of feed to Privatization Contractor at $1 million/day with up to 60 days delay, depending on availability of schedule float at time of difficulty.)	$900,000
Residual (with fluidic sampler)	20%	50%	80%		$1.7 million ($100,000 if one of the analyses is saved by having at-tank solids analysis)	$5.9 million ($100,000 if one of the analyses is saved by having at-tank solids analysis)	$850,000

*Most Likely Likelihood times Most Likely Consequence.

By using a nested fixed-depth sampler and at-tank analysis system for process control, the time to obtain and analyze process control samples will be reduced. For a given processing rate, less time for sampling and analysis will increase the time allowed to adjust the feed, should the feed be out of specification. In addition, the cost to take and analyze the process control samples will be reduced because (1) the effort will not require an entire sampling crew to take the samples, (2) no transportation to the 222-S Laboratory will be required, and (3) no 222-S Laboratory analysis will be required.

B.1.3 Critical Risk 25—"Waste Certification Strategy Not Yet Defined"

The risk is twofold: (1) that the schedule to stage the low-activity waste (LAW) feed will increase as a result of the need to adjust the feed batch more than once and (2) that analytical results may not be available in time to meet schedules. If DOE finds out too late that the composition is not within specification, there will not be time to adjust the feed without either invoking an idle facilities penalty or paying some compensation to the Privatization Contractor for processing off-specification feed. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Mini-mum	Most likely	Maxi-mum	Minimum	Most likely	Maximum	
Initial (Baseline)	Same as Section B.1.2, Critical Risk 22			Same as Section B.1.2, Critical Risk 22			$13.5 million plus $900,000 (duplicates CR-022)
Residual (with fluidic sampler)	Same as Section B.1.2, Critical Risk 22			Same as Section B.1.2, Critical Risk 22			$850,000 (duplicates CR-022)

*Most Likely Likelihood times Most Likely Consequence.

By using a nested, fixed-depth sampler and at-tank analysis system for process control, the time to obtain and analyze process control samples will be reduced. Thus the risk is reduced that the analytical results will not be available in time to meet processing schedules.

B.1.4 Critical Risk 31—"Waste Feed Specification Disputes"

The risk is that waste feed, which the Project Hanford Management Contract Team analysis shows as being in specification, may be unacceptable to the Privatization Contractor based on the results of their analysis, thereby delaying waste delivery to the Privatization Contractor. This could cause the idle facility penalty to be invoked or the necessity for DOE to pay compensation to the Privatization Contractor for processing off-test material. The likelihood of this occurring and the consequence if it does occur are given in the table below.

Using a nested, fixed-depth sampler, samples may be taken while the mixer pump is running. Thus a more technically defensible representative sample may be taken using this sampler. Also, the Privatization Contractor has successfully used this technology in other plants. The fact that it is more defensible and that the Privatization Contractor has successfully used the technology increases the likelihood that disputes will not occur over the representativeness of the sample. Thus the risk of disputes is reduced. It is possible that the likelihood and consequence values for these will be modified during contract negotiations for Phase I, Part B; therefore, these values should be revisited after the Phase I, Part B Notification-to-Proceed has occurred and contract values are available for the incremental cost associated with processing out-of-specification feed.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	20%	50%	80%	1 repeat at $300,000 (if DOE negotiates a reasonable compensation model for out-of-specification feed)	6 repeats of $300,000 each = $1.8 million (6 additional times of taking a grab sample and getting it analyzed at 222-S @ $300,000; if DOE negotiates a reasonable compensation model for out-of-specification feed)	6 repeats at $1 million each = $6 million (if DOE needs to restage or if feed adjustments cause lack of feed to Privatization Contractor at $1 million/day with up to 60 days delay, depending on availability of schedule float at time of difficulty)	$900,000
Residual (with fluidic sampler)	20%	50%	80%	90% of above = $270,000	90% of above = $1.6 million	90% of above = $5.4 million	$810,000
Initial (Baseline)	0%	1%	10%	15 days; consequence will depend on available float: could be $1 million/day; assume float is available: $0 million	45 days; consequence will depend on available float: could be $1 million/day; Estimate: 30 days float and 15 days impact = $15 million	60 days; consequence will depend on available float: could be $1 million/day: $60 million	$150,000
Residual (with fluidic sampler)	0%	1%	10%	$0 (Recycling doesn't use up the available float)	$0 (Recycling doesn't use up the available float)	$0 (Recycling doesn't use up the available float)	$0

*Most Likely Likelihood times Most Likely Consequence.

B.2 WASTE FEED DELIVERY RISKS

B.2.1 RE-043 (from Technical Basis Review (TBR) 130.B45)

The risk is that more than one significant field LAW sampling-equipment development (development of a 500-mL sample capability) and deployment will be required. This would mean that another piece of sampling equipment would need to be developed. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	80%	100%	100%	$8 million	$12.0 million	$20 million	$12.0 million
Residual (with fluidic sampler)	0%	10%	100%	$5 million	$10 million	$20 million	$1 million

*Most Likely Likelihood times Most Likely Consequence.

By developing this sampler and analysis system, the risk of needing to develop another sample system is reduced. Note that by developing this sampler DOE is, in fact, incurring the cost of the consequence of this risk and, therefore, is just breaking even on the mitigation of this risk.

B.2.2 RE-044 (From TBR 130.B45)

The baseline assumes that any one high-level waste (HLW) sampling event will be less than 1,000 mL. The risk is that the Privatization Contractor will require larger volumes; therefore, more than one sampling event will be required for each transfer, or an alternative sampling method would need to be developed. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	80%	90%	100%	$3 million	$6.1 million	$20 million	$5.5 million
Residual (with fluidic sampler)	0%	10%	100%	$3 million	$6.1 million	$20 million	$0.6 million

*Most Likely Likelihood times Most Likely Consequence.

The application of the nested, fixed-depth sampler can provide the ability to take larger samples in a single event if the contract with the Privatization Contractor requires larger volumes. By developing this sampler and analysis system, the risk of needing to develop another sample system is reduced.

B.2.3 RE-065 (From TBR 150.B34) (Risk Involves LAW Source Tanks: 12 Tanks)

The risk is that the Privatization Contractor will require larger sample quantities. If a new method for sampling is not developed, more grab samples will need to be taken. The likelihood of this occurring and the consequence if it does occur are given in the table below.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	30%	80%	90%	$200,000: cost of grab sampling at $10,000 each, times number of samples needed each yr (4), times duration (5 yr)	$200,000: cost of grab sampling at $10,000 each, times number of samples needed each yr (4), times duration (5 yr)	$200,000: cost of grab sampling at $10,000 each, times number of samples needed each yr (4), times duration (5 yr)	$160,000
Residual (with fluidic sampler)	30%	80%	90%	$20,000 (10% of above)	$20,000 (10% of above)	$20,000 (10% of above)	$16,000

*Most Likely Likelihood times Most Likely Consequence.

By using a nested, fixed-depth sampler, larger samples can be taken, thus eliminating the need for many additional grab samples.

B.2.4 RE-069 (From TBR 150.B38) (Risk Involves LAW Source Tanks: 12 Tanks)

There is a risk that the staged feed will not meet the feed specification envelopes. This would require the feed to be adjusted and then resampled. If too much time is required for adjustment and resampling, DOE may have to pay penalties for idle Privatization Contractor facilities. The likelihood of this occurring and the consequence if it does occur are given in the table below.

By using a nested, fixed-depth sampler and at-tank analysis system for process control, the time to obtain and analyze process control samples will be reduced. With a smaller time for sampling and analysis, the rate at which feed can be staged to deliver to the Privatization Contractor will be increased. Thus, the risk of DOE not meeting the contractual processing rate will be decreased.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	20%	50%	80%	$0	$1,000	$60,000 (see CR-022)	$500,000 (duplicates CR-022)
Residual (with fluidic sampler)	Duplicates CR-022 20%	Duplicates CR-022 50%	Duplicates CR-022 80%	Duplicates CR-022; $0 (float will accommodate)	Duplicates CR-022; $0 (float will accommodate)	Duplicates CR-022; $0 (float will accommodate)	Duplicates CR-022

*Most Likely Likelihood times Most Likely Consequence.

B.2.5 RE-071 (From TBR 150.B42) (Risk Involves LAW Source Tanks: 12 Tanks)

The risk is that the schedule to stage the feed will increase as a result of the need to adjust the feed batch more than once. If adequate schedule float is not available, DOE may incur penalties for the Privatization Contractor's idle facilities. The likelihood of this occurring and the consequence if it does occur is given in the table below.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	80% chance that it will happen once	90% chance that it will happen once	100% chance that it will happen once	15 days; consequence will depend on available float: could be $1 million/day; assume float is available: $0	45 days; consequence will depend on available float: could be $1 million/day; Estimate: 30 days float and 15 days impact = $15 million	60 days; consequence will depend on available float: could be $1 million/day $60 million	$13.5 million
Residual (with fluidic sampler)	80% Duplicates CR-022	90% Duplicates CR-022	100% Duplicates CR-022	$0; assume float is available; duplicates CR-022	$0; assume float is available; duplicates CR-022	$0; assume float is available; duplicates CR-022	$0 Duplicates CR-022

*Most Likely Likelihood times Most Likely Consequence.

By using a nested, fixed-depth sampler and at-tank analysis system for process control, the time to obtain and analyze process control samples will be reduced. For a given processing rate, less time for sampling and analysis will increase the time allowed to adjust the feed, should the feed be out of specification Thus, the risk of a schedule slip is reduced, as are potential penalties for the Privatization Contractor's idle facilities.

B.2.6 RE-093 (From TBR 160.A46)

There is a risk that more than 1liter of sample will be required. This could increase the exposure of the sampling crew to radiation from the tank waste. The likelihood of this occurring and the consequence if it does occur are given in the table below, first for the costs and then for the radiation exposure.

	Likelihood			Consequence			Risk value*
	Mini-mum	Most likely	Maxi-mum	Minimum	Most likely	Maximum	
Initial (Baseline)	30%	80%	90%	$200,000 cost of grab sampling at $10,000 each, times # of samples needed each year (4), times duration (5 years)	$200,000 cost of grab sampling at $10,000 each, times # of samples needed each year (4), times duration (5 years)	$200,000 cost of grab sampling at $10,000 each, times # of samples needed each year (4), times duration (5 years)	$160,000
Residual (with fluidic sampler)	3%	8%	9%	$200,000; cost of grab sampling at $10,000 each, times number of samples needed each year (4), times duration (5 yr)	$200,000; cost of grab sampling at $10,000 each, times number of samples needed each year (4), times duration (5 yr)	$200,000; cost of grab sampling at $10,000 each, times numer of samples needed each year (4), times duration (5 yr)	$16,000
Initial (Baseline)	30%	80%	90%	Exposure associated with taking 20 grab samples	Exposure associated with taking 6 grab samples	Exposure associated with taking 16 grab samples	Exposure associated with taking 18 grab samples

	Likelihood			Consequence			Risk value*
	Mini-mum	Most likely	Maxi-mum	Minimum	Most likely	Maximum	
Residual (with fluidic sampler)					Fewer unusual occurrences and less exposure associated with one additional sample for each of the staging tanks	Fewer unusual occurrences and less exposure associated with one to two additional samples for each of the staging tanks	Fewer unusual occur-rences and less exposure associated with one to two additional samples for each of the staging tanks

*Most Likely Likelihood times Most Likely Consequence.

The use of a nested, fixed-depth sampler will reduce the risk of unusual occurrences and reduce operator exposure because the sampler system will be completely contained—unlike the taking of grab samples.

B.2.7 RE-096 (From TBR 160.A52) (Risk Involves HLW Source Tanks: Two to Three Tanks)

The risk is that leaching of the HLW sludge will cause the elemental concentrations of selected constituents to become out of specification. The feed then will need to be adjusted to get back within specifications. The likelihood of this occurring and the consequence if it does occur are given in the table below.

If the HLW feed is out of specification after pretreatment, the feed will need to be adjusted. The reprocessing time will be reduced by the use of a nested, fixed-depth sampler and analysis system for the process control samples after feed adjustment. This will help minimize the risk that DOE will incur an increased cost for processing out-of-specification feed or for treating the out-of-specification feed.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	20%	50% (To-be-determined, as this value is partly dependent on the magnitude of the incremental cost for processing out-of-specification feed.)	80%	$5 million; DOE will negotiate the incremental cost to be paid to Privatization Contractor to receive and process out-of-specification feed. This will be related to the idle facility costs.	$50 million; DOE will negotiate the incremental cost to be paid to Privatization Contractor to receive and process out-of-specification feed. This will be related to the idle facility costs.	$100 million; DOE will negotiate the incremental cost to be paid to Privatization Contractor to receive and process out-of-specification feed. This will be related to the idle facility costs.	$25 million
Residual (with fluidic sampler)	15%	40%	65%	$5 million	$50 million	$100 million	$20 million It is most likely that DOE will accept an increased cost of processing out-of-specification feed as an alternative to the idle facilities clause being invoked.

*Most Likely Likelihood times Most Likely Consequence.

B.2.8 RE-099 (From TBR 160.A66) (Risk Involves HLW Source Tanks: Two to Three Tanks)

There is a risk that larger HLW samples will be required than could be obtained from the grab sampling method. Use of the core sampling truck could delay feed deliver up to two months, thus forcing DOE to pay penalties for the Privatization Contractor's idle facilities. The likelihood of this occurring and the consequence if it does occur are given in the table below.

The nested, fixed-depth sampler will have the capability of taking larger samples than with the existing grab sampling method. Thus, the risk of the existing grab sampler not being able to accommodate larger samples will be mitigated.

	Likelihood			Consequence			Risk value*
	Minimum	Most likely	Maximum	Minimum	Most likely	Maximum	
Initial (Baseline)	30%	80%	90%	$200,000; cost of grab sampling at $10,000 each, times number of samples needed each year (4), times duration (5 yr)	$200,000; cost of grab sampling at $10,000 each, times number of samples needed each year (4), times duration (5 yr)	$200,000; cost of grab sampling at $10,000 each, times number of samples needed each year (4), times duration (5 yr)	$160,000
Residual (with fluidic sampler)	30%	80%	90%	10% of above—$20,000	10% of above—$20,000	10% of above—$20,000	$16,000

*Most Likely Likelihood times Most Likely Consequence.

B.3 AFFECTED TECHNICAL BASIS REVIEWS

In a review of the mid-level logic and readiness-to-proceed activity for the retrieval and disposal mission, the following TBRs were found to contain risks that could be mitigated by the nested, fixed-depth fluidic sampler and at-tank analysis system.

- TBR 150.B34, Obtain AN-105 Feed Qualification Sample from 241-AP-102
- TBR 150.B50, Obtain AN-105 Feed Qualification Sample from 241-AP-104
- TBR 150.E10, Obtain AN-104 Feed Qualification Sample from 241-AP-102
- TBR 150.E45, Obtain AN-104 Feed Qualification Sample from 241-AP-104
- TBR 150.G10, Obtain AW-101 Feed Qualification Sample from 241-AP-102
- TBR 150.G45, Obtain AW-101 Feed Qualification Sample from 241-AP-104
- TBR 150.J10, Obtain AN-103 Feed Qualification Sample from 241-AP-102
- TBR 150.J45, Obtain AN-103 Feed Qualification Sample from 241-AP-104
- TBR 150.V10, Obtain AP-101 & AW-104 Feed Qualification Sample from 241-AP-102
- TBR 150.V45, Obtain AP-101 & AW-104 Feed Qualification Sample from 241-AP-104
- TBR 150.I10, Obtain AY-101 Feed Qualification Sample from 241-AP-102
- TBR 150.I45, Obtain AY-101 Feed Qualification Sample from 241-AP-104
- (There are no TBRs for 241-AN-107 because it is analyzed from sample in source tank)
- TBR 150.L10, Obtain AN-102 Feed Qualification Sample from 241-AP-102
- TBR 150.L45, Obtain AN-102 Feed Qualification Sample from 241-AP-104
- TBR 150.M10, Obtain AN-106 Feed Qualification Sample from 241-AP-102
- TBR 150.M45, Obtain AN-106 Feed Qualification Sample from 241-AP-104
- TBR 150.R10, Obtain SY-101 Feed Qualification Sample from 241-AP-102
- TBR 150.R45, Obtain SY-101 Feed Qualification Sample from 241-AP-104
- B.3.19 TBR 150.T10, Obtain SY-103 Feed Qualification Sample from 241-AP-102
- TBR 150.T45, Obtain SY-103 Feed Qualification Sample from 241-AP-104
- TBR 160.A52, Pretreat 241-AZ-101
- TBR 160.A66, Obtain HLW Feed Qualification Grab Samples of Solids from 241-AZ-101

- TBR 160.F65, Pretreat 241-AZ-102
- TBR 160.F50, Obtain HLW Feed Qualification Grab Samples of Solids from 241-AZ-102
- TBR 160.H27, Pretreat 241-AY-102
- TBR 160.H50, Obtain HLW Feed Qualification Grab Samples of Solids from 241-AY-102

B.4 REDUCTION OF RISK ASSOCIATED WITH DEPLOYMENT OF THE NESTED, FIXED-DEPTH FLUIDIC SAMPLER

Risk Number	Initial Risk Value ($ million)	Residual Risk Value ($ million)	Is Risk Independent?	LAW Risk Reduction ($ million)	HLW Risk Reduction ($ million)	Combined Risk Reduction (LAW + HLW) ($ million)	Rationale for Risk Not Being Independent
CR-09	14.7	6.3	yes	8.4		8.4	
CR-022	0.9	0.85	yes	0.05		0.05	
CR-022	13.5	0	yes	13.5		13.5	
CR-25	13.5 + 0.9	0.85	no				This is a duplicate of a portion of CR-022 because it also deals with schedule slip.
CR-31	0.9 + 0.15	0.81	yes	0.24		0.24	
RE-043	12.0	1	yes	11.0		11.0	
RE-044	5.5	0.6	yes		4.9	4.9	
RE-065	0.16	0.016	yes	0.144		0.144	
RE-069	Dupli-cates CR-022	Dupli-cates CR-022	No				This is a duplicate of a portion of CR-022 because it also deals with resampling and analyzing due after adjustment.
RE-071	13.5	0	No				This is a duplicate of a portion of CR-022 because it also deals with schedule slip.
RE-093	0.16	0.016	yes		0.144	0.144	
RE-093	exposure	exposure	yes		exposure	exposure	
RE-096	25.0	20.0	yes		5.0	5.0	
RE-099	0.16	0.016	yes		0.144	0.144	
Total				33.334	10.188	43.522	

From the above table, the return on investment can be calculated. The return on investment was determined as the sum of the independent risk reductions divided by the investment (Development Costs plus Deployment Costs) to install the sampler and analysis capability in one LAW feed source tank plus two LAW feed staging tanks and two HLW feed source/staging tanks. The risk reductions are the differences of the risk values between the initial (baseline) and residual (with the fluidic sampler and analysis system installed). All dollars in the table are in millions.

Three returns on investment were calculated. The first is for the combined LAW and HLW sample/analytical system. The second calculation is for the LAW case only. The third is for the incremental case for adding the HLW case to the LAW case. (Note: This may be important in a decision of whether to continue the development of the HLW after the LAW system is completed.) The calculations follow:

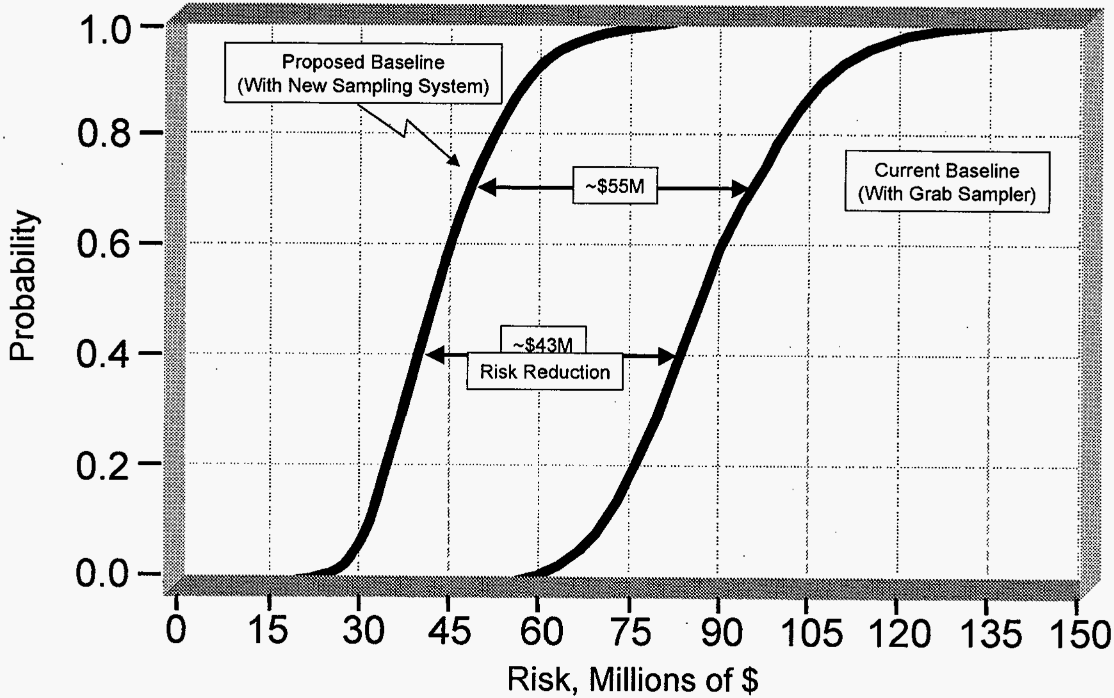
- Return on investment (LAW+HLW) = 43.5/18.1 = 2.4
- Return on investment (LAW only) = 33.3/12.0 = 2.8
- Return on investment (increment for adding HLW case to LAW case) = 10.2/6.1 = 1.7

It is important to note that all of these calculations are based on the product of most probable likelihood and most probable consequence for the initial and residual risks. Because both the minimum values and maximum values for the likelihood and consequence also were estimated, it is possible to use Monte Carlo techniques to establish a more rigorous solution to the difference in risks and, thus, the return on investment. A Monte Carlo technique was completed for the risks of one of the cases above—LAW+HLW. The results are shown in Figure B-1. In the figure, the difference between the initial risk and the residual risk is about $50 million for most probabilities. Using this value for the risk reduction, the return on investment would be 2.8. Although this is a more rigorous solution, the individual values of the likelihood and consequence were not, as yet, generated from a consensus of experts (only from the authors input); therefore, only one of the three cases was run at this time. Updated versions of the deployment strategy will include risk solution sets and corresponding return-on-investment solution sets that were generated using Monte Carlo techniques based on data generated from a consensus of experts.

B.5 REFERENCES

K. N. Jordan, 1998, *Tank Waste Remediation System Retrieval and Disposal Mission Readiness-to-Proceed Memorandum*, HNF-2019, Rev. 1, prepared by Lockheed Martin Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Figure B-1. Projected Risk Reduction Associated with Nested, Fixed-depth Fluidic Sampling and Analysis System.



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APPENDIX C

BUDGETS

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APPENDIX C

BUDGETS

C.1 BUDGET FOR DEPLOYMENT OF SAMPLER/ANALYTICAL SYSTEM AFTER FIRST PROTOTYPICAL SYSTEM

Combined Sampler and Analytical System	
Level 2 Component Specification	$ 85,000
Sampler	
Design/Procurement/Fabrication Sampler	680,000
Design/Procurement/Fabrication Interface	300,000
Deployment Documentation	10,000
Operational Testing and Operator Training	225,000
In-Tank Deployment Documentation	130,000
Hot Installation Plan	10,000
Readiness Assessment Requirements Definition	10,000
Readiness Review	10,000
In-Tank Installation and Functional Checkout	20,000
Readiness Checklist for Continued Operation	10,000
Analytical System	
Definitive Design	180,000
System Deployment Documentation	60,000
Procurement/Fabrication	115,000
Operational Testing and Operator Training	210,000
Readiness Assessment—At-Tank Installation and Operation	100,000
Hot Installation	85,000
Readiness Checklist for Continued Operation	10,000
Integration with At-tank Analysis System	50,000
Total	$ 2,300,000

C.2 BUDGET BY TASK BY YEAR BY FUNDING SOURCE FOR LAW FEED STAGING SAMPLER SYSTEM

Year	Program	Level 2 Comp Specification	Analysis Concept Development	Sampler Design/ Fabrication	Design Analysis System	Cold Test/ Acceptance Sampler	Deployment Sampler	Deployment Analysis System	Procurement/ Fabrication Analysis System
1999	TFA	30		500					
	IG			500					
	Robotics		150						
	CMST		263		237				
	FETC								
	EM-30		35	125	55	10			
	Total	30	448	1125	292	10			
2000	TFA					270			
	IG					10[1]			
	Robotics								300
	CMST							140	60
	FETC								600
	EM-30					170	425	20	
	Total					450	425	160	960
2001	TFA						[2]		
	IG						0[1]		
	Robotics							300	
	CMST						100	100	
	FETC						500	500	
	EM-30						285	375	
	Total						885	1275	

[1]IG will support AEA Technology Engineering Services, Inc.'s contribution during cold testing of the analytical system. $390,000 of the IG funding will be directed for the high-level waste in 2000. All of the IG funding ($400,000) will be directed for high-level waste in 2001.

[2]TFA funding ($300,000 will be directed for high-level waste in 2001.

CMST = Characterization, Monitoring, and Sensor Technology
FETC = Federal Energy Technology Center
TFA = Tanks Focus Area.
EM-30 = Office of Waste Management
IG = International Grant

APPENDIX D

SUMMARY OF SAMPLER ALTERNATIVES EVALUATION

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APPENDIX D

SUMMARY OF SAMPLER ALTERNATIVES EVALUATION

Claghorn et al. (1997) considered three alternatives:

Grab Sampler
: Least expensive; available at present; highest radiation exposure and potential for personnel contamination; most susceptible to being delayed by weather conditions.

Core Sampler
: Expensive; available at present; susceptible to being delayed by weather conditions.

Isolok Sampler
: Expensive initial installation, lowest per feed batch (recurring) cost; not ready for full operation by 10/01/2000; substantially reduces radiation exposure; not susceptible to being delayed by weather conditions.

REFERENCE

R. D. Claghorn, J. D. Galbraith, and T. B. Salzano, 1997, *Alternatives Generation and Analysis for the Phase I Intermediate Waste Feed Staging System Design Requirements*, HNF-SD-TWR-AGA-001, Rev. 1, prepared by Numatec Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

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