U.S. Department of Energy
P.O. Box 450, MSIN H6-60
Richland, Washington, 99352

JAN 3 0 2012

12-WTP-0039

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004-2901

TRANSMITTAL OF DEFENSE NUCLEAR FACILITIES SAFETY BOARD (DNFSB) RECOMMENDATION 2010-2 IMPLEMENTATION PLAN (IP) DELIVERABLE 5.5.3.4

Dear Mr. Chairman:

This letter provides you the deliverable responsive to Commitment 5.5.3.4 of the U. S. Department of Energy (DOE) plan to address Waste Treatment and Immobilization Plant (WTP) Vessels Mixing Issues; IP for DNFSB 2010-2.

The attached report identifies tank farm sampling and transfer capability test requirements to be documented in a test requirements document. This report provides input to separate IP deliverables for conduct of testing. Testing will 1) determine the range of physical properties of tank waste expected to be staged, sampled, and transferred to include uncertainties with waste properties, and 2) determine the capability of tank farm staging tank sampling systems to provide samples that will appropriately characterize the tank waste and be in compliance with the Waste Acceptance Criteria (WAC). These tests will reduce technical risk associated with overall mixing, sampling, and transfer of waste to WTP so that all WAC requirements are met. Testing will be completed with both small scale and full scale equipment at Hanford and off-site facilities.

Large-Scale Integrated Mixing System Expert Review Team review comments and resolution are also included with this transmittal.

If you have any questions, please contact me at (509) 376-6727 or your staff may contact Ben Harp, WTP Start-up and Commissioning Integration Manager at (509) 376-1462.

Sincerely,

Dale E. Knutson, Federal Project Director
Waste Treatment and Immobilization Plan

WTP:WRW

Attachments (2)

cc w/attach
M. N. Campagnone, 3G-092
D. M. Busche, BNI
W. W. Gay, BNI
F. M. Russo, BNI
R. G. Skwarek, BNI
D. G. Huizenga, EM-1
M. B. Moury, EM-1
T. P. Mustin, EM-1
K. G. Picha, EM-1
J. S. Trent, EM-1
C. S. Trummell, EM-1
A. C. Williams, EM-2.1
M. G. Thien, WRPS
S. A. Saunders, WRPS
M. R. Johnson, WRPS
BNI Correspondence
WRPS Correspondence

ATTACHMENT 1
to
12-WTP-0039

TRANSMITTAL OF DEFENSE NUCLEAR FACILITIES SAFETY BOARD (DNFSB) RECOMMENDATION 2010-2 IMPLEMENTATION PLAN DELIVERABLE 5.5.3.4

- Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements, RPP-PLAN-41807, Rev 1A

(Total Number of Pages including coversheet: 32)

DOCUMENT RELEASE FORM

(1) Document Number:	RPP-PLAN-41807	(2) Revision Number: 1A 4PM 01/24/12	(3) Effective Date: 01/24/2012
(4) Document Type:	☐ Digital Image ☐ Hard copy ☒ PDF ☐ Video	(a) Number of pages (including the DRF) or number of digital images	32
(5) Release Type	☐ New ☐ Cancel	☒ Page Change ☐ Complete Revision	
(6) Document Title:	Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements		
(7) Change/Release Description:	Figure 1-1 was revised to include corrections.		
(8) Change Justification:	Figure 1-1 required corrections.		

(9) Associated Structure, System, and Component (SSC) and Building Number:	(a) Structure Location: N/A		(c) Building Number: N/A	(e) Project Number: N/A
	(b) System Designator: N/A		(d) Equipment ID Number (EIN): N/A	

(10) Impacted Documents:	(a) Document Type	(b) Document Number	(c) Document Revision
	None		

(11) Approvals:

(a) Author (Print/Sign): Mike Thien — Date: 1/24/12

(b) Reviewer (Optional, Print/Sign):

_____ Date: _____ _____ Date: _____

_____ Date: _____ _____ Date: _____

_____ Date: _____ _____ Date: _____

(c) Responsible Manager (Print/Sign): Scott Saunders — Date: 1/24/2012

(12) Distribution:

(a) Name	(b) MSIN	(a) Name	(b) MSIN
Ray Skwarek	H3-28	Mike Thien	B1-55
Scott Saunders	B1-55	Doug Larsen	B1-55
Richard Garrett	H3-25	Garth Duncan (WTP)	16-B
Steve Barnes (WTP)	17-A	Donna Busche (WTP)	17-A
Wendell Wrzesinski (ORP)	H6-60	Rob Gilbert (ORP)	H6-60
Jian-Shun Shuen (ORP)	H6-60	Loni Peurrung (PNNL)	K9-09
Ben Harp (ORP)	H6-60	Tom Fletcher (ORP)	H6-60

Release Stamp: DATE: Jan 25, 2012 STA: 4 HANFORD RELEASE ID: 17

(13) Clearance	(a) Cleared for Public Release	(b) Restricted Information?	(c) Restriction Type:
	☑ Yes ☐ No	☐ Yes ☑ No	

(14) Clearance Review (Print/Sign): **APPROVED** By Laura N Solano at 9:39 am, Jan 25, 2012 — Date:

DISTRIBUTION SHEET

To	From	Page 1 of 1
Document Control	Tamika Pirtle Moore	Date January 24, 2012
Project Title/Work Order		EDT No. N/A; DRF
Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements RPP-PLAN-41807 Rev. 1A		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
Whitney Dobson	B1-55				
Ted Wooley	B1-56				
Kearn Lee	B1-55				
Tamika Pirtle Moore	B1-55				
Phil Keuhlen	MS4-A2				

A-6000-135 (10/97)

Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements

M.G. Thien,
Washington River Protection Solutions, LLC,
Richland, WA 99352

R.A. Sexton
AEM Consulting, LLC

U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: UC: N/A
Cost Center: 2PD00 Charge Code: 201342
B&R Code: N/A Total Pages: 32

Key Words: Tank Farm Mixing and Sampling, Waste Feed Delivery, DNFSB Recommendation 2010-2

Abstract: This plan addresses the general approach, test requirements, and overall schedule of the Mixing and Sampling Program to support waste feed delivery to the Waste Treatment and Immobilization Plant (WTP). The program will include activities to determine the range of waste physical properties that can be retrieved and transferred to WTP, based on testing and analysis. It will also determine the capability of the tank farm staging, tank sampling systems to obtain samples that can be characterized to assess the bounding physical properties important for the Waste Acceptance Criteria based on testing and analysis.

Tank Operations Contractor (TOC) **RECORD OF REVISION**	(1) Document Number: RPP-PLAN-41807

(2) Title
Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release	
		(5) Resp. Engr. (print/sign/date)	(6) Resp. Mgr. (print/sign/date)
0	Initial release, titled, "Waste Feed Delivery Small Scale Mixing and Sampling Demonstration Plan"	Paul Townson, 8/27/2009	Dave Shuford, 8/27/2009
1	Revised to reflect some expansion of the program. Renamed, "Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements"	Richard Sexton, 1/16/2012	Mike Thien, 1/16/2012
1A TPM 01/24/12 RS	Page 1-3, Figure 1-1, was revised to include the following: changed the Test Requirements Final Gap Analysis Commitment number to 5.5.3.9, and changed LAW to low-activity waste in the Legend	Tamika Pirtle Moore Tamika Pirtle Moore 1/24/2012	Mike Thien Mike Thien 1/24/12

1A TPM 01/24/12

RPP-PLAN-41807
Rev. 1A

Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements

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

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

washington river
protection *solutions*

P.O. Box 850
Richland, Washington 99352

RPP-PLAN-41807
Rev. 1A

Waste Feed Delivery Mixing and Sampling Program Plan and Test Requirements

M.G. Thien
Washington River Protection Solutions, LLC

R.A. Sexton
AEM Consulting, LLC

Date Published
January 2012

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

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

washington river
protection solutions

P.O. Box 850
Richland, Washington

EXECUTIVE SUMMARY

The primary purpose of the Tank Operations Contractor (TOC) Waste Feed Delivery (WFD) Mixing and Sampling Program is to mitigate the technical risks associated with the ability of the tank farms feed delivery systems to mix and sample high-level waste (HLW) feed adequately to meet the Waste Treatment and Immobilization Plant (WTP) Waste Acceptance Criteria (WAC). The TOC has identified two critical risks TOC-08-65 and TOC-12-64 per the TFC-PLN-39, *Risk and Opportunity Management Plan*, Rev. F-1. These two risks address emerging waste WAC and sampling method requirements. In addition, in November 2011, U.S. Department of Energy (DOE) issued the Implementation Plan (IP) for the Defense Nuclear Facility Safety Board Recommendation (DNFSB) 2010-2, DOE Rec. 2010-2, Rev. 0, *Implementation Plan for Defense Nuclear Safety Board Recommendation 2010-2*, which addresses safety concerns associated with the ability of the WTP to mix, sample, and transfer fast settling particles.

This document revises the previous plan to incorporate results to date and to include new requirements associated with DNFSB Recommendation 2010-2. This document satisfies DNFSB 2010-2 Sub-Recommendation 5, Commitment 5.5.3.4 and addresses the general approach, test requirements, and overall schedule of the WFD Mixing and Sampling Program to support WFD to the WTP including:

- Determine the range of waste physical properties that can be retrieved and transferred to WTP based on testing and analysis and
- Determine the capability of the tank farm staging, tank sampling systems to obtain samples that can be characterized to assess the bounding physical properties important for the WAC based on testing and analysis.

In order to meet the expanded TOC WFD Mixing and Sampling Program objectives identified above, test requirements have been established. Three major areas of testing will be executed during this Program:

- Limits of performance - determine the range of waste physical properties that can be mixed, sampled and transported under varying modes of operation.
- Solids accumulation - perform scaled testing to understand the behavior of remaining solids in a DST during multiple fill, mix, and transfer operations that are typical of the HLW feed delivery mission.
- Scaled performance - demonstrate mixing, sampling, and transfer performance using a realistic simulant representing a broad spectrum of Hanford waste to meet WTP WAC Data Quality Objective (DQO) sampling confidence requirements.

This work will be managed under the One System concept where TOC and WTP work scope will be integrated and managed under one management organization (RPP-54471, Rev. 0 and 24590-WTP-CH-MGT-11-008, *2020 Vision One System IPT Charter*). Waste Feed Delivery activities will be integrated and coordinated with the WTP Vessel Completion Team including Large-Scale Integrated Testing (LSIT) Program.

This document presents the foundation for the description of more detailed simulant and testing requirements that will define the TOC mixing and sampling program and satisfy additional DNFSB Recommendation 2010-2 Implementation Plan requirements.

CONTENTS

FIGURES

TABLES

TERMS

Abbreviations and Acronyms

ASME	American Society of Mechanical Engineers
DOE	U.S. Department of Energy
DNFSB	Defense Nuclear Facilities Safety Board
DST	double-shell tank
DQO	data quality objective
HLW	high-level waste
ICD	Interface Control Document
IP	Implementation Plan
LAW	low-activity waste
LSIT	Large-Scale Integrated Testing
M3	External Flowsheet Review Team Major Issue 3
MDT	mixing demonstration tank
MJP	mixer jet pump
ORP	Office of River Protection
PSDD	particle size density distribution
RPP	River Protection Project
RSD	Remote Sampler Demonstration
SRNL	Savannah River National Laboratory
SSMD	Small-Scale Mixing Demonstration
SST	single-shell tank
TOC	Tank Operations Contract
TPA	Tri-Party Agreement
TSD	Transfer System Demonstration
WAC	waste acceptance criteria
WFD	Waste Feed Delivery
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant

Units

ft	feet
in	inch
gpm	gallons per minute

1.0 INTRODUCTION AND PURPOSE

1.1 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) is responsible for management and completion of the River Protection Project (RPP) mission, which comprises both the Hanford Site tank farms operations and the WTP. The RPP mission is to store, retrieve, and treat Hanford's tank waste; store and dispose of treated wastes; and close the tank farm waste management areas and treatment facilities by 2047 in a safe, environmentally compliant, cost-effective, and energy-effective manner.

The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (aka Tri-Party Agreement [TPA]) requires DOE to complete the RPP tank waste treatment mission by September 30, 2047. A key aspect of implementing that mission is to construct and operate the WTP (ORP-11242, *River Protection Project System Plan*). The WTP is a multi-facility plant that will separate and immobilize the tank waste for final disposition. Tank Farm waste treatment is scheduled to be completed by 2047.

The RPP work scope is currently performed by two primary contractors: Washington River Protection Solutions, LLC (WRPS) (the TOC); and Bechtel National, Inc. (BNI), the WTP Construction and Commissioning Contractor. WRPS is responsible for the construction, operation, and maintenance activities necessary to store, retrieve, and transfer tank wastes; provide supplemental pretreatment for tank waste; and provide secondary low-activity waste (LAW) treatment, storage, and/or disposal of the immobilized product and secondary waste streams. BNI is responsible for the design, construction, and commissioning of a WTP Pretreatment Facility, two vitrification facilities (one for HLW and one for LAW), a dedicated analytical and radiochemical laboratory, and supporting facilities to convert radioactive tank wastes into glass for long-term storage or final disposal.

1.2 PURPOSE

One of the primary goals of the TOC is to provide waste feed to the WTP for treatment and immobilization. This goal will partially be met through the TOC Mixing and Sampling Program, which includes the following activities:

- Small-scale mixing demonstration (SSMD),
- Remote sampler demonstration (RSD),
- Savannah River National Laboratory (SRNL) scouting studies, and
- Future full-scale testing.

The primary purpose of the TOC Mixing and Sampling Program is to mitigate the technical risks associated with the ability of the tank farms WFD systems to mix and sample HLW feed adequately to meet the WTP WAC (24590-WTP-RPT-MGT-11-014, *Initial Data Quality Objectives for WTP Feed Acceptance Criteria)*. Consistent batch tank waste feed is desirable for efficient operations of the WTP. However, uniform feed is not achievable for the full complement of tank waste properties for the current WFD Mixing and Sampling baseline.

The TOC has identified two critical risks TOC-08-65 and TOC-12-64 per the TFC-PLN-39. These risks address emerging WAC and sampling method requirements. In addition, the WFD Mixing and Sampling Program will address system performance related to WTP safety issues raised by the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2010-2 and the Implementation Plan submitted by DOE to resolve these issues (DOE Rec. 2010-2). TOC's responsibilities are only associated with Sub-recommendation 5 commitments of DOE Rec. 2010-2. Table 1-1 provides a summary of the DNFSB commitments that the TOC is either leading or participating with as a co-lead.

Table 1-1. Defense Nuclear Facility Safety Board Recommendation 2010-2 Commitments

Commitment No.	Due Date	POC	Commitment Description
5.5.3.1	12/31/2012	WRPS/BNI	Initial gap analysis between Waste Treatment and Immobilization Plant (WTP) waste acceptance criteria (WAC) and tank farm sampling and transfer capability
5.5.3.2	6/30/2012	WRPS	Evaluation of waste transferred to WTP
5.5.3.3	12 months after LSIT Testing Report complete	BNI	Update WAC Requirements based on WTP Large-Scale Integrated Testing results
5.5.3.4	1/31/2012	WRPS	Identification of tank farm sampling and transfer capability test requirements to be documented in a test requirements document
5.5.3.5	3/30/2012	WRPS	Definition of simulants for tank farm performance testing
5.5.3.6	5/31/2012	WRPS	Test plan to establish Tank Farm performance capability
5.5.3.7	3/31/2013	WRPS	Results from Tank Farm performance testing
5.5.3.8	12/31/2012	WRPS	Issue remote sampler test report
5.5.3.9	8/31/2014	WRPS/BNI	Complete Final Gap Analysis
5.5.3.10	5/31/2015	WRPS/BNI	Optimize WTP WAC Data Quality Objectives

The execution schedule including DNFSB Recommendation 2010-2, Sub-Recommendation 5 commitments is depicted in Figure 1-1.

In summary, the TOC will conduct tests to determine the range of waste physical properties that can be retrieved and transferred to WTP, and determine the capability of tank farm staging tank sampling systems to provide samples that will appropriately characterize the tank waste and determine compliance with the WAC. These tests will reduce the technical risk associated with the overall mixing, sampling, and transferring of HLW feed to WTP and ensure that all WAC requirements are met. Testing will be completed with both small-scale and full-scale equipment at Hanford and multiple off-site facilities.

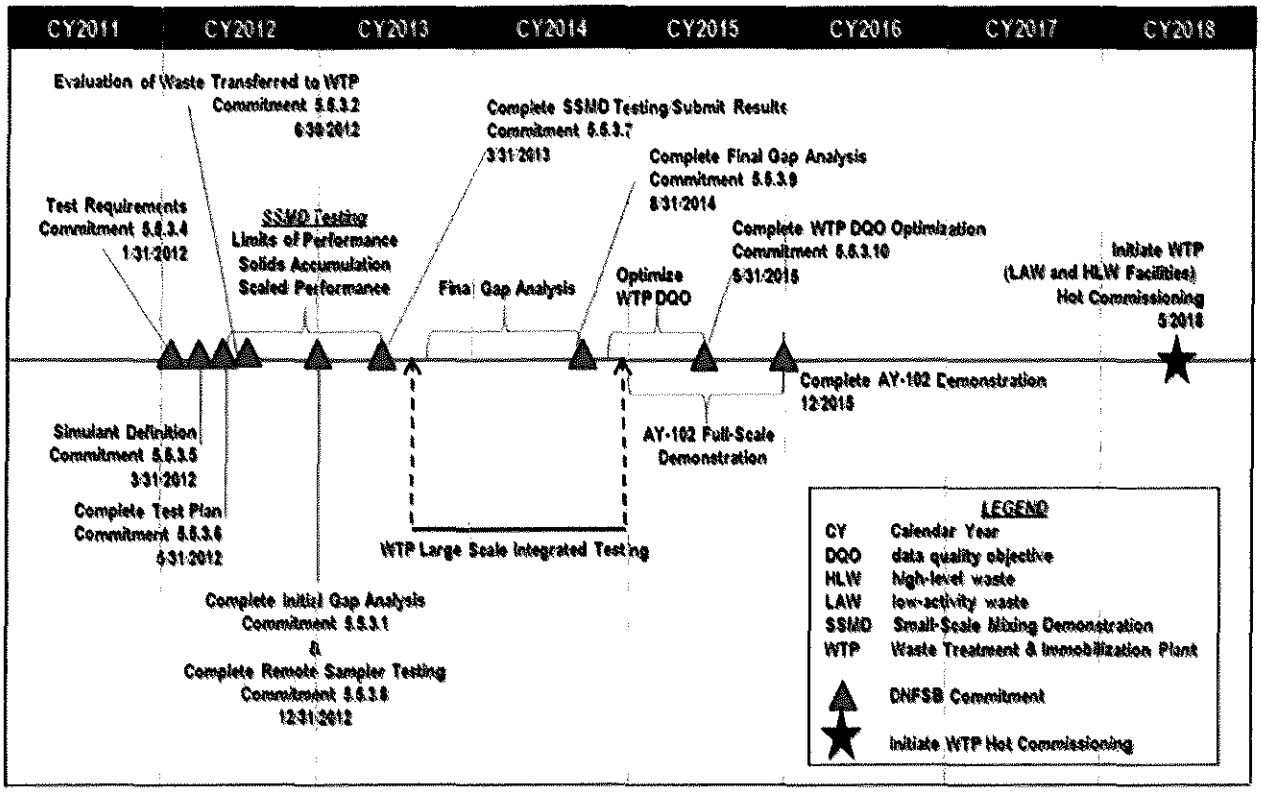

Figure 1-1. Mixing and Sampling Program Integrated Schedule

This document satisfies DNFSB Recommendation 2010-2, Commitment 5.5.3.4 and addresses the general approach, test requirements, and overall schedule of the Mixing and Sampling Program to support WFD to the WTP including:

- Determine the range of waste physical properties that can be retrieved and transferred to WTP based on testing and analysis
- Determine the capability of the tank farm staging tank sampling systems to obtain samples that can be characterized to assess the bounding physical properties important for the WAC based on testing and analysis

Additional information will be generated as part of parallel work that will further define test requirements. This parallel work includes Commitment 5.5.3.2, which estimates, based on current information, the range of waste physical properties that can be transferred to WTP and Commitments 5.7.3.1 and 5.7.3.4 which identify potential new WAC requirements based on preliminary documented safety analyses coupled with projections of potential WAC requirements based on recent assessments. Decisions on how to adjust test requirements based on these evolving requirements will be made and documented in updates to the issued WFD Mixing and Sampling Program Plan and Test Requirements.

This work will be managed under the One System concept where TOC and WTP workscope will be integrated and managed under one management organization (RPP-51471, and 24590-WTP-CH-MGT-11-008, *2020 Vision One System IPT Charter*). Waste Feed Delivery activities will be integrated and coordinated with the WTP Vessel Completion Team including the Large-Scale Integrated Testing (LSIT) Program.

2.0 BACKGROUND

The ORP has defined the interface between the two major RPP contractors, BNI and TOC, in a series of interface control documents (ICDs). The primary waste interface document is 24590-WTP-ICD-MG-01-019, *ICD-19-Interface Control Document for Waste Feed* (ICD-19). Iterative updates to ICD-19 are anticipated as new information is generated. ICD-19 identifies a significant incompatibility between the TOC baseline equipment configuration and capabilities and the WTP baseline design and regulatory assumptions requirements for tank WFD to WTP. Section 2.3 states that the TOC baseline sampling plans and capabilities are not currently compatible with WTP sample and analysis requirements as described in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD)* (), the 24590-WTP-RPT-MGT-11-014, *Initial Data Quality Objectives for WTP Feed Acceptance Criteria* (), and the 24590-WTP-RPT-MGT-04-001, *Regulatory Data Quality Optimization Report*.

The WTP dynamic processing analysis and batch processing planning currently assumes each staged HLW feed tank is mixed and delivered in consistent feed delivery batches of 145,000 gallons (ICD-19). Consistent, as used here is intended to mean that the first 145,000 gallon batch has the same solids composition as the last 145,000 gallon batch. Small-scale testing completed to date (RPP-50557, *Tank Waste Mixing and Sampling Update* , Rev. 0b) concludes that the first feed tank (AY-102) can likely be sampled adequately using DST mixing systems, but that additional uncertainties related to data uncertainty, optimizing system performance, applicability to all feed tanks, and understanding emerging WTP solids handling risks still need to be addressed.

The SSMD project has focused on the first HLW planned for transfer to WTP, (AY-102) and now will apply knowledge gained to the remaining planned feed delivery DSTs. Double-Shell Tanks are 75 feet (ft) in diameter, and have an operating liquid height of up to 454 inches. The staged HLW feed tanks could have settled solids (sludge) heights of up to 70 in. The baseline configuration will include two, 400 horsepower mixer pumps, with opposing 6-inch diameter nozzles that will recirculate tank waste at approximately 5,200 gallons per minute (gpm) per nozzle. The mixer pumps have the ability to be rotated such that the nozzles can cover a full 360° of rotation. A slurry transfer pump will be installed near the center and bottom of the DSTs to transfer HLW slurry to the WTP up to 140 gpm.

The historical TOC baseline plan includes mixing of waste in a DST using slurry mixer pumps and then performing grab and core sampling for sludge and supernate feed waste acceptance analysis. A proposed alternative mixing and sampling concept based on a dynamic mixed tank includes a transfer pump driven recirculation and sampling loop, which allows remote sampling of the to-be-delivered feed stream during tank mixing and a real-time direct critical velocity measurement.

Work conducted over the past 5 years has introduced information that may result in new WAC requirements. This workscope includes mixing assessments that have indicated that:

- Controls on waste particles size and density may be required, and
- New controls on waste containing fissile material particles of larger size and density than previously assumed may be required.

The WFD Mixing and Sampling Program Plan and Test Requirements will be updated to address changes in the WAC. The evaluation of waste to be transferred to WTP, identified as Commitment 5.5.3.2, June 30, 2012, will define the preliminary range of physical properties of waste anticipated to be delivered to WTP.

2.1 WORK COMPLETED TO DATE

Initial SSMD Program results demonstrated that equivalent mixing performance, from a solids distribution perspective, can be achieved in two different scaled tanks. These results provide a foundation for beginning to explore other performance parameters that were investigated in the sampling and batch transfer phase. Reports identify a range of scaling factors (approximately 0.25 to 0.3) applicable to DST mixing (RPP-49740, *Small-Scale Mixing Demonstration Sampling and Batch Transfer Result Report*). The sampling and batch transfer testing results have indicated the feasibility of mixing the tanks adequately to provide a representative sample to the transfer system. The results indicated that more difficult and fastest settling particles can be delivered to the transfer system.

The RSD constructed at Monarch Machine and Tool in Pasco, Washington, includes a flow loop to allow testing of the Isolok® sampler and a PulseEcho ultrasonic measurement device to determine critical velocities. The flow loop is fitted with an Isolok®[1] sampler, and a Coriolis meter for measuring bulk density. The flow loop is currently configured to accept the PulseEcho system which will be installed later.

Initial work evaluated the ability of the Isolok to take a representative and repeatable sample based on analyte concentrations when compared to a known concentration. The data showed the Isolok® has a propensity to collect large and higher density particles over small and lower density particles. The cause of this bias is being evaluated.

Previous testing of the PulseEcho system at PNNL's PDL-East facility showed that the system is capable of measuring the point at which solids begin to fall out of solution, which is considered the onset of critical velocity. Various simulants were tested with similar results.

Appendix A presents a summary of the objective and outcome of testing results to-date and the five workshops conducted in chronological order, which provides a foundation for future work. While the initial work has demonstrated the concept functionality for the first feed tank, uncertainties remain that must be addressed. The remaining uncertainties to be resolved related to optimizing system performance include the applicability of data to all tank waste and understanding the emerging WTP solids handling risks.

2.2 MIXING PROGRAM ADJUSTMENTS

2.2.1 Defense Nuclear Facility Safety Board Recommendation 2010-2

DNFSB Recommendation 2010-2 has raised WTP safety issues related to tank farms ability to mix, sample, and transfer solids. In response, DOE developed an implementation plan to resolve these issues (DOE Rec. 2010-2). As discussed in Section 1.0, this program plan and test requirements document satisfies Commitment 5.5.3.4 of the Implementation Plan.

[1] Isolok® is a registered trademark of Sentry Equipment Corporation of Oconomowoc Wisconsin.

2.2.2 October 2011 Optimization Workshop Recommendations

During October 10 – 12, 2011, the TOC held their 5th Mixing and Sampling workshop in Richland, Washington (WRPS-1105293. *Small Scale Mixing Demonstration Optimization Workshop Meeting Minutes).* The Mixing and Sampling Program has been augmented by internationally recognized mixing experts, National Laboratory and University experts, and TOC and WTP project subject matter experts. DNFSB technical staff was also present to observe the proceedings. Participants are listed in the minutes, WRPS-1105293. Over the past three years, the experts progressively evaluated the SSMD Project results to-date. During this workshop, the Expert Panel addressed a detailed list of outstanding key uncertainties including:

- Simulant Selection,
- Bounds of Equipment Performance,
- Scale-up,
- Solids Accumulation,
- Nozzle Performance, and
- Sparse Particle Detection.

The output from this workshop has been used to provide guidance in the development of this plan.

The primary output from the workshop was a group discussion of how to best prioritize the activities necessary to address the remaining uncertainties and to ensure that the work is appropriately integrated with the WTP LSIT activities. The group consensus identified the following path forward priorities in order of importance:

1. Bounds of Equipment Performance
   - Continue using the SSMD platform to determine the largest particles of two different representative densities that the system is capable of mixing, sampling, and transporting
   - Integral with above workscope, select appropriate complex simulants and accurate analytical techniques to characterize the material of interest
   - Integrate workscope with WTP simulant selection
2. Batch Accumulation Behavior
   - Initiate new phase of testing to understand the behavior of remaining solids in a DST during multiple fill, mix, and transfer operations that are typical of HLW WFD
3. Scale Up
   - Continue gathering data to enable the estimation of full-scale mixing, sampling, and solids transfer (but not as a specific test driver)
   - Scaled performance information can be gathered while testing for the two primary performance objectives; bounds of equipment performance and batch accumulation
4. Operational Improvements

- Evaluate parameters with less significant impact on mixing to confirm the significance impact to these parameters (e.g., capture velocity sensitivity, mixer pump rotation rate)

In addition, cold, full-scale mixing and sampling demonstration was recommended to be completed prior to demonstration in an actual DST, recognizing that sustained mixing test results from Tank AY-102 will not likely be available.

3.0 MIXING AND SAMPLING PROGRAM OBJECTIVES

The original objective of the Mixing and Sampling Program was to mitigate the technical risks associated with the ability of the tank farms WFD systems to mix and sample HLW feed adequately to meet the WTP WAC. Testing focused on the ability to achieve adequate mixing and representative sampling, minimizing variability between batches transferred to WTP. Testing to date (RPP-49740) has demonstrated the potential ability to adequately sample and deliver AY-102 simulated waste using currently planned DST mixing and transfer systems.

While several uncertainties remain regarding the ability to characterize DST waste adequately, larger mission uncertainties related to the compatibility of tank farms feed systems with the WTP receipt systems remain to be addressed. The current TOC Mixing and Sampling Program is being executed in a phased approach that will:

- Optimize requirements,
- Demonstrate the viability of systems to meet those requirements in a small-scale environment, and upon successful small-scale demonstration, and
- Exhibit system capability in a full-scale DST (i.e., DST which will be providing hot commissioning feed to WTP).

Upon successful demonstration of mixing and sampling in the first DST, a systematic evaluation of all HLW feed batches will be completed to identify any unique configurations or operating scenarios that may require additional demonstration activities.

This plan defines requirements for testing to address tank farm feed mixing, sampling, characterization and transfer system capability, which will support a gap analysis of capabilities to sample characterize and transfer waste to WTP that conforms with ICD-19. Testing may be accomplished through expansion of the Mixing and Sampling Program scope, including testing in conjunction with WTP large scale integrated testing, or by other means.

To ensure tank farms and WTP mixing and sampling systems are integrated and compatible (i.e., execution of the One System approach) and the uncertainties identified in RPP-50557 are addressed, the TOC Mixing and Sampling Program is being expanded to include:

- Define DST mixing, sampling, and transfer system limits of performance with respect to the ability to transfer waste to the WTP with varying physical properties, solid particulates sizes and densities, and under various modes of operation (i.e., defining the expected range of particle size and density and consideration of data uncertainty).
- Define propensity of solid particulates to build up, and the potential for concentration of fissile material over time in DSTs during the multiple fill, mix, and transfer operations expected to occur over the life of the mission.
- Define ability of DST sampling system to collect representative slurry samples and in-line critical velocity measurements from a fully mixed waste feed staging tank.
- Develop sufficient data and methodology to predict confidently full-scale DST mixing, sampling, and transfer system performance; such that a gap analysis against WTP feed receipt system performance can be adequately completed.

As described in Revision 0 of this plan, confirmation of full scale mixing performance is planned to be performed in conjunction with the installation and testing of the first mixer pumps in AY-102. This is scheduled to be completed well ahead of the first HLW feed delivery need date to allow for any operational adjustments that may be identified.

4.0 TESTING REQUIREMENTS

In order to meet the expanded TOC Mixing and Sampling Program objectives identified in Section 3.0. the following test requirements have been established. Three major areas of testing will be executed during this Program:

- Limits of performance,
- Solids accumulation, and
- Scaled performance.

Testing will be designed to bound system performance taking into account the uncertainty of known waste characteristics.

4.1 LIMITS OF PERFORMANCE

The objective of Limits of Performance activities is to determine the range of waste physical properties that can be mixed, sampled and transported under varying modes of operation. Integral with this activity is the selection of appropriately complex simulants, integrated with WTP simulant selection and supported by accurate analytical techniques to characterize the material of interest. Particle size and density are expected to be the most important solids properties. Particle shape is assumed to be less important but this will be confirmed by SRNL studies being done to support the WTP LSIT program and will be re-addressed, if necessary.

To meet this objective, the following specific activities, including inter-related sampling activities, are planned (the sequence of activities is not implied by this list):

- Use SSMD platform to test progressively larger particle size and density to identify the largest size and density of particles that can be mixed and transferred from the SSMD transfer system.
- Use a full-scale transfer system demonstration platform to define limits of particle size performance that cannot be tested with SSMD platform (i.e., physical size constraints of the scaled equipment).
- Evaluate the performance of Isolok® sampler to:
  - Collect representative and repeatable samples from the RSD loop over a range of simulant formulations representing potential HLW slurry conditions and
  - Identify particle size and density limitations of the Isolok® sampler in the RSD Loop.
- Evaluate the design of prototypic mechanical handling and conveyor systems (including placement and retrieval of a sample container from Isolok® sampler) and the placement of the sample bottle into a cask located on a motorized conveyor to assure that the sample bottle and shielded cask are compatible with the mechanical handling equipment used by the receiving laboratory.
- Determine the Isolok® sampler operating limits for temperature and pressure.
- Evaluate the performance of PulseEcho critical velocity detection instrument (developed by PNNL, PNNL-20350) over a range of simulant formulations representing potential HLW slurry conditions.

4.2 SOLIDS ACCUMULATION

The objective of Solids Accumulation activities is to perform scaled testing to understand the behavior of remaining solids in a DST during multiple fill, mix, and transfer operations that are typical of the HLW feed delivery mission. Testing will focus on accumulation of total solids over time and the propensity for simulated fissile material localized concentration to change over time. The following specific activities are planned to meet this objective:

- Use the SRNL mixing demonstration tank (MDT) platform to:
  - Perform scouting studies to evaluate remaining bulk material in a tank after a series of full MDT campaigns of feed tank pump-out and prototypic refill (similar to planned WFD campaigns to WTP) and
  - Determine what particles or materials remain in the MDT after a series of full tank pump out and prototypic refills (i.e., concentration and locations where the fastest settling particles accumulate in the tank heels).
- Use the SSMD platform to perform testing under NQA-1 requirements to:
  - Further refine SRNL demonstrated behavior of solids accumulation and simulated fissile material localized concentration and
  - Determine concentrations and locations of specific particles in the remaining tank heels.

4.3 SCALED PERFORMANCE

While test data collected to date has provided some insight to mixing, sampling, and transfer performance (e.g. RPP-50557), more data is needed to confidently predict full-scale performance. The objective of Scaled Performance activities is to test at two scales, mixing and sampling; then transfer performance using a realistic simulant representing a broad spectrum of Hanford waste to meet WTP WAC DQO sampling confidence requirements. The following activities will be completed to meet this objective:

- Use the SSMD platform (43 inch and 120 inch tanks) to test at two or more mixing velocities to:
  - Evaluate the development of "mounds" and transfer behavior,
  - Define scaled test approaches to apply these test results at full scale, and
  - Develop a basis for confirming the velocities used for scaled testing.
- Use the RSD platform to define operational steps for the Isolok® sampler and describe functional requirement for supporting systems necessary for field deployment

5.0 SIMULANT PHILOSOPHY

DNFSB 2010-2Commitment 5.5.3.5 (due March 31, 2012) will define the simulants to be used for testing. The shift in testing philosophy away from demonstrating adequate performance in a conservative simulant (e.g. non-cohesive particulates in water) to a testing philosophy that defines limits of performance to support a gap analysis also requires a shift in simulant philosophy.

Successful completion of the TOC Mixing and Sampling Program depends upon the selection of appropriately complex simulants that are reflective of expected tank conditions, integrated with WTP simulant selection, and supported by accurate analytical techniques to characterize the material of interest. Testing will use increasingly complex simulants that are more representative of all Hanford tank waste.

The simulant that has been used in past SSMD activities, which consists of water and a five component particulate mix (PNNL 20637, *Comparison of Waste Feed Delivery Small Scale Mixing Demonstration Simulant to Hanford Waste*), is considered more challenging than AY-102 waste and waste composites except for particulates at the very high end of the size and density curve. The SSMD simulant, however, is not as challenging compared to the other HLW sludges that may be encountered in other DSTs. As much as 50% by volume of the HLW sludge waste particulate is more challenging than the SSMD simulant relative to properties such as settling velocity, pipeline transport, and Archimedes number (PNNL-20637). Therefore a simulant that is more representative of these more challenging tank wastes must be developed to support the TOC Mixing and Sampling Program objectives.

ASTM C1750-11 (*Standard Guide for Development, Verification, Validation, and Documentation of Simulated High-Level Tank Waste*) will be used for guidance on simulant selection. The guidelines will be used to help identify realistic simulants that envelope the complete range of physical properties for the high-level waste expected to be staged for WTP WFD.

The simulants developed and used for these testing activities will be integrated with WTP LSIT simulant development to ensure consistency in testing and will draw from the following experience and lessons learned:

- SSMD Program,
- WTP External Flowsheet Review Team Major Issue 3 (M3) Program, and
- SRNL mixing and sampling testing for both Savannah River and Hanford tank farm wastes.

Simulants will use non-hazardous materials except where hazardous components are required to produce a chemically representative simulant, in which case all safety requirements will be followed.