The Secretary of Energy
Washington, DC 20585

November 10, 2011

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

Dear Mr. Chairman:

On September 23, 2011, you were informed that the Department of Energy (DOE) needed an additional 45 days to prepare the Implementation Plan (IP) for your Recommendation 2010-2, *Pulse Jet Mixing at the Waste Treatment and Immobilization Plant.* Our respective staffs met on October 6-7, 2011, to address the final comments received from your staff. I am pleased that we were able to use the additional time to come to agreement on our IP.

DOE's IP for Recommendation 2010-2 is enclosed. I want to thank your staff for working closely with us during the 45-day period to resolve those areas where the IP needed additional clarification.

If you have any further questions, please contact me or Mr. David Huizenga, Acting Assistant Secretary for Environmental Management, at (202) 586-7709.

Sincerely,

Steven Chu

Enclosure

Department of Energy Plan to Address Waste Treatment and Immobilization Plant Vessel Mixing Issues

Revision 0

Implementation Plan for Defense Nuclear Safety Board Recommendation 2010-2

November 10, 2011

EXECUTIVE SUMMARY

On December 17, 2010, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 2010-2, *Pulse Jet Mixing at the Waste Treatment and Immobilization Plant.* The recommendation addressed the need for the U.S. Department of Energy (DOE) to ensure that the Hanford Waste Treatment and Immobilization Plant (WTP), in conjunction with the Hanford tank farm waste feed delivery system, will operate safely and effectively during a 40-year operating life to eliminate the safety hazards posed by Hanford Site tank wastes.

Operation of the WTP and tank farm system is important to safety because delays in treating and immobilizing the tank waste pose significant risks to the public, workers, and the environment. WTP lifecycle mission completion requires that the pulse jet mixing and transfer systems perform reliably and effectively for decades, and that technical issues with the performance of these components be resolved in time to enable DOE to meet its commitment with the Washington State Department of Ecology and the Environmental Protection Agency to begin WTP operation in 2019.

The safety issues relevant to DNFSB's concerns about the pulse jet mixing and transfer systems are identified in Recommendation 2010-2 as:

1. Accumulation of fissile material at the bottom of vessels leading to potential criticality.
2. Generation and accumulation of hydrogen resulting from the accumulation of solids.
3. The possibility that accumulating solids will interfere with the vessel-level detection system leading to loss of pulse jet mixer (PJM) control and overblows (discharge of air from the PJM).

The direct and underlying causes of these issues are incomplete knowledge to validate assumptions made in design of the relevant physical processes and associated scaling rules that apply to them, and uncertainty in precisely predicting the behavior of tank waste slurries as they are mixed, sampled, and transferred. The objective of this implementation plan is to understand and mitigate the identified safety issues.

The following five areas are in need of greater study:

1. PJM control and performance.
2. Validation and verification of computational fluid dynamics software planned for use on the project.
3. Determination of PJM mixed vessel system capabilities and performance margins.
4. Criticality.
5. Hanford tank waste feed characteristics.

The results of the studies performed as part of this implementation plan will further inform and supplement the project requirements to complete safety analysis, formally implement process vessel design modifications and subsequent design verification, and define specific WTP waste feed acceptance criteria (WAC) and associated controls. This implementation plan prioritizes testing accordingly.

DOE accepted Recommendation 2010-2 on February 10, 2011, noting that the recommendation is consistent with DOE's current direction related to resolving pulse jet mixing and transfer system uncertainty. This implementation plan outlines the actions DOE and its contractors will take to demonstrate that pulse jet mixing and transfer systems will perform adequately at full scale, including the identification and verification of necessary modifications to design features or operating strategies.

Actions include:

- Conducting large-scale testing with representative simulants to support evaluation of vessel mixing performance against vessel mixing requirements.
- Establishing a testing approach and success criteria, addressing uncertainty in WTP design, and determining the adequacy of design features. In addition, this testing will establish performance capabilities for vessel heel dilution and cleanout systems to allow waste particles that may not be mixing with the bulk of the waste to be moved forward to the melters.
- Completing verification and validation requirements of computational models for pulse-jet-mixed vessels in accordance with the ASME V&V 20-2009, *Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer*.
- Developing and updating the WTP WAC based on conclusions from assessment of vessel performance.
- Defining the impact on the waste retrieval, feed delivery, and feed certification processes resulting from any limitations of the WTP mixing and transfer systems, and evaluating the ability to obtain representative samples from the waste feed tanks to ensure the WTP WAC can be reliably enforced.
- Defining engineered features that may be necessary to ensure feed is delivered to WTP consistent with the WAC. The need for additional engineered features will be based on testing coordinated between the tank farms and WTP, providing information to perform a gap analysis.
- Identifying the technical and safety-related risks that remain unresolved upon completion of the large-scale testing and establishing risk mitigation strategies.

DOE also includes the following commitments:

1. Determine waste simulant properties that represent the high-level wastes that will be transferred to WTP. Conduct testing using the developed waste simulant.

2. Testing to determine the limits of performance of the vessel mixing and transfer systems.
3. Testing to confirm that pulse-jet-mixed vessels can be adequately operated using prototypic equipment (e.g., control systems) during multi-batch operations.
4. Design and testing heel removal and cleanout systems.
5. Determining sampling capabilities and evaluating sampling correctness and performance against requirements for process control and safety.

This plan assumes that schedule commitments are supported by project cost and schedule profiles, that longer term large-scale testing will include at least one Newtonian and one non-Newtonian vessel configuration, that design completion testing will provide information necessary to verify performance of control and instrumentation system designs, that sufficient quantities of simulant are available to support testing, and that longer term testing will follow design verification tests to optimize operation.

The WTP Federal Project Director is the Responsible Manager. The WTP Federal Project Director will ensure the activity is satisfactorily completed and formally closed.

CONTENTS

APPENDIX

TERMS

ASME	American Society of Mechanical Engineers
BNI	Bechtel National, Incorporated
CFD	computational fluid dynamics
CRESP	Consortium for Risk Evaluation with Stakeholder Participation
CSER	Criticality Safety Evaluation Report
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
EFRT	External Flowsheet Review Team
EM	U.S. Department of Energy, Office of Environmental Management
FLUENT	Software made by ANSYS\ Corporation used to model flow, turbulence, heat transfer, and chemical reactions
HLW	high-level waste
ICD	interface control document
IP	implementation plan
LOAM	Low Order Accumulation Model
LSIT	large-scale integrated testing
NETL	National Energy Technology Laboratory
ORP	U.S. Department of Energy, Office of River Protection
PJM	pulse jet mixer
PNNL	Pacific Northwest National Laboratory
SSMD	Small-Scale Mixing Demonstration
TOC	Tank Operations Contractor
V&V	verification and validation
WAC	waste acceptance criteria
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant

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1.0 BACKGROUND

1.1 RECOMMENDATION 2010-2

On December 17, 2010, the Defense Nuclear Facilities Safety Board (DNFSB) issued Recommendation 2010-2, *Pulse Jet Mixing at the Waste Treatment and Immobilization Plant*, which identified technical and safety issues related to performance of the pulse jet mixing and transfer systems in the Waste Treatment and Immobilization Plant (WTP). The Secretary of Energy accepted Recommendation 2010-2 on February 10, 2011, with clarifications to ensure that the U.S. Department of Energy (DOE) was clear on the scope of commitments to be addressed in DOE's implementation plan (IP). On May 20, 2011, the DNFSB notified DOE that the initial communication was a partial rejection of the recommendation and reaffirmed the primary elements of the recommendation. The reaffirmation letter also provided additional information to be considered in DOE's analysis of the principal safety issues, determination of underlying causes, and development of the IP.

The recommendation identified the following unresolved concerns:

- Small-scale testing had not investigated the performance limits of the pulse jet mixer (PJM) system design.
- Computer simulation of mixing performance, such as the Low Order Accumulation Model (LOAM), had not been verified and validated, yet had been used to advance the WTP mixing design.
- The WTP safety strategy depends on obtaining representative samples from high-level waste (HLW) feed tanks to support WTP waste feed certification requirements, and from WTP process vessels to ensure safety-related criteria are met. This capability had not been demonstrated in the Hanford tank farms or WTP process vessels.
- The WTP Project team had altered mixing performance criteria and made changes to the waste acceptance criteria (WAC), such as reducing the allowable solids concentration for WTP feed to address unfavorable mixing test results.
- Specifications for capabilities of planned heel dilution, vessel pump-out, and visual inspection to address potential risk and uncertainties had not been established.
- Prototypic PJM control and instrumentation testing had not been performed for the range of anticipated slurry properties and operating conditions.

The DNFSB summarized three significant safety issues in a letter to the DOE's Assistant Secretary for Environmental Management (EM) on January 6, 2010, related to pulse jet mixing:

> Dense particles rich in plutonium and uranium are expected to settle preferentially on the bottom of tanks. These settled particles may form a sediment layer with sufficient fissile mass in a geometric configuration such that a criticality accident is credible. Furthermore, if the vessels are not well mixed, samples drawn from the vessels to ensure that such an event does not occur will not be representative.

> The development of a sediment layer on the bottom of tanks may reduce the effectiveness of the pulse jet mixing systems below that assumed in the design. As a result, an initially thin sediment layer could grow sufficiently to retain significant quantities of flammable gas. The existence of a deep sediment layer would not be recognized by plant operators because there is no instrumentation that indicates the quantity of sediment. Gas release events from this sediment layer could exceed the lower flammability limit in the vessel headspace and result in an explosion.
>
> The presence of a deep sediment layer may also have a detrimental effect on the performance of bubbler systems used to measure the tank level and average density in the vessels. The tank level and average density are inputs to the calculation of the drive time of the pulse jet mixers, which is relied upon to prevent overblows. The cumulative effect of many overblows could result in the material failure of components internal to process vessels located in black cells.

Recommendation 2010-2 provided seven sub-recommendations to address these technical concerns and safety issues, as summarized below. Plans to implement these specific sub-recommendations are provided in Section 5.

- Develop a large-scale test plan to define the limits of the WTP pulse jet mixing and transfer systems given the complete range of physical properties for the HLW stored in the Hanford tank farms.
- Develop waste simulants for testing of the mixing and transfer system that envelope the complete range of physical properties for the HLW stored in the Hanford tank farms.
- Complete verification and validation of any computational models used by the WTP Project team based on the results from the large-scale testing.
- Demonstrate the ability to obtain representative samples of the solids and liquids in all vessels, including demonstrating that representative samples can be obtained even if the assumed WTP design particle size or density is exceeded.
- Define the impact on the waste retrieval, feed delivery, and feed certification processes due to any limitations of the WTP mixing and transfer systems, and demonstrate the ability to obtain adequately representative samples from the waste feed tanks to ensure the WTP WAC can be reliably enforced.
- Establish functional design criteria for the heel dilution, heel pump-out, and visual inspection functions, and demonstrate the capability and limits of these systems through large-scale testing.
- Identify the technical and safety-related risks that remain unresolved upon completion of the large-scale testing and establish suitable risk management strategies.

On February 10, 2011, DOE accepted the DNFSB Recommendation 2010-2 and provided clarifications.

The DNFSB reaffirmation letter summarized several of the primary elements of the Recommendation as follows:

- Testing must be done at the proper scale to demonstrate the limits of vessel mixing and transfer system performance. These tests must be conducted using appropriate waste simulants with properties that conservatively envelop the properties of the HLW stored in Hanford's tank farms.
- Testing must demonstrate that PJM-mixed vessels can be adequately operated using prototypic equipment (e.g., control systems) during multi-batch operations.
- Testing must demonstrate that representative samples can be taken from tank farm waste feed delivery tanks to meet the WTP WAC, and from the WTP process vessels to meet safety-related operating requirements.
- The heel removal and cleanout systems must be designed and tested as early as practicable, the performance limits for these systems established, and the limits of their operation factored into the development of the WAC and the operating envelope of WTP.

DOE and its two prime contractors, Bechtel National, Inc., (BNI) and Washington River Protection Services, LLC (WRPS), agree with the content of Recommendation 2010-2. This IP demonstrates DOE's and its contractors' common understanding of the underlying technical and safety issues along with the underlying causes. The commitments provided in this IP are based on DOE's analysis of the recommendation and associated input from other external reviewers and stakeholders.

1.2 STATUS

The design of the integrated tank farm and WTP processing system has been underway for 15 years. To minimize the time to retrieve and treat the tank waste, DOE and its contractors pursued a concurrent design and construction project approach. Identification of technical issues and work to address these technical issues concurrent with the design process resulted in an undesirable condition where the design and safety bases are not currently aligned.

The Hanford tank farms and the WTP safety bases were developed independently, with the potential for inconsistent evaluation of the hazards associated with the storage, mobilization, transport, mixing, sampling, and treatment of Hanford tank waste. As a result, feed interface requirements have not matured to the point where the operational strategy of tank farm and WTP systems are integrated, providing waste feed that can be safely and efficiently treated and immobilized. The following key events led to this condition.

- The WTP design for pulse-jet-mixed vessels was developed by BNFL Inc. and its subcontractor AEA and was provided to BNI in the advanced conceptual design at project transition in 2001.
- The initial WTP Preliminary Documented Safety Analysis was prepared and approved in 2002.

- BNI work in 2003 to 2005 to assess the PJM vessel design focused on non-Newtonian conditions and did not assess bounding conditions for solids suspension. Newtonian designs were evaluated with 22 micron, median-sized particles with a specific gravity of 2.9. This was highlighted in the External Flowsheet Review Team (EFRT) and was defined as "Issue M3" by BNI. The EFRT stated, "Denser, larger particles may be more difficult to suspend than those considered in the current design, resulting in the possible accumulation of settled particles."

- Efforts to assess the PJM vessel designs based on the EFRT concern between 2006 and 2010 indicated PJMs in vessels that handle high solids content were underpowered to meet mixing requirements.

- Testing and vessel assessments performed to close the EFRT mixing issue were completed in 2010 and vessel design modifications to improve mixing performance were recommended. Vessel closure records also included the following recommendations:

  - Update the preliminary Criticality Safety Evaluation Report (CSER) based on results and evaluation provided in the analyses, which indicated sampling in WTP could not achieve the degree of homogeneity required in the WTP CSER.

  - Perform large-scale testing to increase confidence in mixing system performance prior to WTP commissioning.

  - Perform testing to demonstrate PJM control with vessels containing stratified solids and varying flow across bubbler tubes.

  - Test the integrated PJM vessel mixing, sampling, transfer, and control systems.

- New characterization information was identified in late 2010 that indicated plutonium dioxide in some tanks could exceed the 10 micron sphere assumption used in WTP PJM-mixed vessel assessments. Assessment of vessel mixing performance with larger plutonium particles and identification of potential controls has not been completed.

In parallel with the WTP activities summarized above, the Tank Operations Contractor (TOC) is pursuing tests to determine double-shell tank (DST) waste retrieval, staging, and characterization system capabilities. This work is ongoing and integration of tank farm and WTP system capabilities and safety bases is not completed.

1.3 ISSUE RESOLUTION

This IP defines the approach and commitments necessary to identify and address technical issues, address safety issues, achieve alignment of WTP and Tank Farm system designs, and achieve alignment with the safety basis to safely retrieve, stage, deliver, treat, and immobilize tank waste. The plan includes the following primary activities:

- Strengthen the interface management process between DOE, BNI, and the TOC to manage technical and regulatory risks crossing the interface.

- Identify and define requirements for waste staging, sampling, transfer, mixing, process control, and heel removal systems.
- Determine WTP system capability, including limits of operation, sampling capability to detect development of an unsafe condition, and capability to correct or eliminate a detected unsafe condition.
- Determine the Tank Farms capability to retrieve, characterize, and deliver tank waste to WTP.
- Define WAC for feed to the WTP and establish controls to ensure the waste delivered to the WTP conforms to the WAC. If batches of tank waste are identified that do not comply with the WAC, then analysis and development of alternative processing strategies or alternative disposal paths will be developed to allow safe treatment and disposal.
- Define engineering features to ensure feed delivered to WTP is within its design bases.

DOE will address comments on PJM vessel mixing performance raised by reviews, including the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and the Pacific Northwest National Laboratory (PNNL). DOE has directed its contractor to establish an Expert Review Team (ERT) comprised of mixing experts with backgrounds in national laboratories, academia, and industry in the development and execution of testing and interpretation of test results. Large-scale integrated testing (LSIT) results will be used to define the limits of operation of the WTP pulse jet mixing and transfer systems. This will support the development of the final WAC for WTP, allow comparison to staged waste feed characteristics developed in the waste feed prequalification process, and allow development of specific administrative controls to ensure transferred waste conforms to the WAC. Testing issues (e.g., scaling, simulants) and test objectives related to PJM performance are further detailed in the resolution approach in each sub-recommendation (as appropriate).

2.0 UNDERLYING CAUSES

This section presents the underlying causes that contributed to the timely identification, understanding, and resolution of the technical and safety issues presented in Section 1. Although the principal safety issues are technical and resolution requires the fundamental knowledge of WTP and tank farms system performance in conjunction with HLW properties, DOE and contractor management systems have also impacted DOE's ability to establish the technical bases for closure on research and technology issues at the WTP.

2.1 Feed Characteristics

There is uncertainty regarding the physical properties of tank waste planned to be delivered to the WTP. The majority of waste characterization information is based on tank waste as it resides in underground storage tanks. Waste delivered to the WTP will be retrieved using inhibited water and other solutions, sheared, and blended with multiple source tanks. Tank farm waste staging and transfer system capabilities are being designed and are under evaluation. WTP design has assumed limits to physical properties that may not bound all waste that could be transferred from the tank farm waste staging systems. Resolution of design and system

capabilities in both tank farms and WTP will define the updates to be made to the WAC (Interface Control Document [ICD]-19). Until this work is complete, requirements for engineered features to ensure feed being delivered to WTP conforms to the WAC cannot be finalized.

2.2 Contract Structure and Regulatory Construct

DOE's establishment of two separate contracts introduced misalignments that were not initially resolved. The two contracts were not effectively integrated or aligned, which created vulnerabilities for the safety basis approval and commissioning of the WTP facilities as well as long-term operations of both the Hanford tank farms and WTP facilities. Consequently, the DOE and its contractors have not effectively integrated technical and regulatory requirements.

2.3 Organization and Management of Technical and Safety Risks

The existing Hanford tank farms and WTP technical and risk management programs are implemented by two different contractors with independent contract requirements and funding allocations. Organizational structure and alignment within DOE, within Hanford tank farms and the WTP, and between the three entities are complex. The existing management system has not effectively identified, tracked, and closed technical and safety risks at the interface between the WTP and tank farms. In addition, both programs identify technical and safety issues, but resolution is focused on managing their respective contract risks (i.e., cost, scope, schedule) and provides no mechanism for allocating shared risk between the two contractors.

2.4 ENGINEERING, PROCUREMENT, AND CONSTRUCTION

DOE's analysis found that a significant contributor to incomplete identification and resolution of technical and safety issues was the concurrent design and construction of the WTP. This approach was chosen to expedite the construction and installation schedule while supporting programmatic and regulatory drivers. This resulted in the identification and resolution of some technical issues after equipment had already been procured and construction was well underway.

3.0 BASELINE ASSUMPTIONS

The key baseline assumptions associated with this IP are as follows:

- Sufficient funding (expense and capital funding) will be available to complete the commitments in this IP. If funding is insufficient, then DOE will reschedule and re-sequence work. Work required to close the technical issues will be completed in a timely manner to support WTP commissioning.
- Sufficient quantities of simulant are available to support the testing schedule.

4.0 NEAR-TERM ACTIONS

4.1 ACCOMPLISHMENTS

- Established the ERTeam to independently review and provide input on the development and execution of testing and interpretation of test results.
- Completed the initial data quality objectives (DQO) for the WTP WAC. This document provides the process to establish the DQOs for the final WAC, which will be required for WTP commissioning. The DQOs will be maintained under configuration management as the WTP identifies the safety-related requirements for the WAC and completes LSIT, and as the Hanford Tank Farms Project completes performance testing of the mixing system.
- Issued a plan to conduct verification and validation of the Computational Fluid Dynamics (CFD) model planned for use to support design verification of PJM mixed vessels.

4.2 COMMITMENTS

A complete list of implementation plan commitments is included in Appendix B.

5.0 SAFETY ISSUE RESOLUTION

This IP defines the approach and commitments necessary to address technical concerns, address safety issues, and achieve alignment of the WTP and tank farms waste treatment system designs and safety bases necessary to safely retrieve, stage, deliver, treat, and immobilize Hanford tank waste. After completion of all commitments in the IP DOE will have:

- Strengthened the interface management process between DOE, BNI, and the TOC to manage technical and regulatory risks crossing the interface (Commitment 5.7.3.2).
- Determined WTP system capability, including limits of operation, sampling capability to detect development of a hazardous condition, and ability to correct or eliminate a hazardous condition (Commitments 5.1.3.6, 5.1.3.7, 5.4.3.6, 5.4.3.7, 5.6.3.6, and 5.6.3.7).
- Determined the tank farm operators' ability to retrieve, characterize, and deliver tank waste to WTP (Commitments 5.5.3.2, 5.5.3.3, 5.5.3.6, and 5.5.3.8).
- Updated ICD-19 to specifically define WAC for the feed to the WTP and established controls to ensure waste delivered to the WTP conforms to the WAC (Commitment 5.7.3.4).
- Defined engineering features to ensure feed delivered to WTP is within the design bases (Commitment 5.5.3.9).
- Established a safety basis approval strategy that will define the process for selecting engineered controls (Commitment 5.0.1).

Limitations in tank waste characterization will be managed in mixing and feed staging systems and limits within ICD-19. Controls and engineering features will ensure feed delivered to the WTP falls within the WTP design basis.

The overarching safety basis approval strategy commitment is listed below. Commitments addressing each DNFSB sub-recommendation follow.

Commitment 5.0.1	**Safety Basis Approval Strategy Document**
Primary Resource:	BNI and WRPS
Deliverable:	Develop a safety basis approval strategy to ensure that the safety basis documents for the Hanford tank farms and the safety basis documents for WTP facilities provide an integrated set of nuclear safety controls that consistently analyze and control hazardous conditions. The integrated strategy will ensure that the WTP can be commissioned and provide a consistent technical basis for the evaluation of emerging issues and maintenance of the safety basis documents.
Target Completion Date:	June 30, 2012

5.1 SUB-RECOMMENDATION 1 – LARGE-SCALE TEST PLAN

Develop a large-scale test plan, including schedule and milestones that addresses the issues raised by the Board in this recommendation, by CRESP in its letter reports addressing pulse jet mixing, and by PNNL. The objective of the test plan should be to define the limits of the WTP pulse jet mixing and transfer systems given the complete range of physical properties for the high-level waste stored in the Hanford Tank Farms. The elements of the test plan should include: (1) design of simulants; (2) design of the prototypic mixing systems, including PJM control and tank level control systems, and the transfer system for the large-scale test; and (3) criteria for review and interpretation of the large-scale test results. The test plan schedule should be constructed such that results from the testing can be used to inform WTP process vessel design decisions. The large scale test platform must integrate the scaling of the mixing and transfer systems such that the scaling of the test vessel is technically defensible.

5.1.1 Issue Description

Prior small-scale tests leave unresolved technical issues on the ability of the PJM mixing, transfer, and sampling systems to mitigate principal safety issues, including:

- Preventing the accumulation of fissile material separated from absorbers that could result in inadvertent criticality.
- Providing adequate mixing to prevent accumulation of flammable gases that could result in deflagration or detonation of gases in the vessel headspace.
- Preventing PJM control system malfunctions (e.g., inaccurate level detection) due to stratification of solids, which could lead to excessive overblows that exceed the structural design criteria.

The areas of key importance to resolving the principal safety issues include:

- Defining requirements for the WAC, sampling, mixing, transfer, and heel management.
- The ability to conduct tests for specific vessel configurations considered to be the most demanding at other than full-scale (some WTP vessels will be tested at full-scale), which represents expected performance over the range of vessel configurations and sizes.
- The range and characteristics of wastes and waste simulants that are relevant to mixing performance that require testing in PJM-mixed vessels.
- The performance limits of PJM-mixed vessels and how these limits compare to actual waste feeds.
- The ability of extraction systems to remove a heel containing particulate material greater than PJM mixing and transfer system design basis from the vessels.
- The ability of instrumentation and control systems to accurately and reliably deliver design mixing energy (pulse volume fraction) and limit overblow events.
- Integrated operation of PJM mixing, transfer, and sampling tests in near-full-scale prototypic conditions.

5.1.2 Resolution Approach

DOE is developing an LSIT program to verify the performance of pulse jet mixing, sampling, and transfer systems and establish performance limits for waste that can be handled safely in WTP. The scope of the LSIT will be finalized after DOE has evaluated and dispositioned the recommendations from key stakeholders (i.e., CRESP, PNNL). The results of DOE's evaluations will be addressed in LSIT documents (e.g., plans, objectives, bases documents, scaling).

An ERT has been established to provide independent technical review and advice on topics related to large scale integrated mixing system test objectives, test design, and the interpretation of test results to the WTP Project Director and Federal Project Director. ERT advice is provided independent of the BNI or DOE technical staffs. The ERT reviews key LSIT program documentation, including but not limited to test specifications, simulant basis documents, test plans, and reports of test results. Reviews that concern "what" or "how" to test will be completed prior to testing. The scope of the ERT reviews include the interpretation of test

results and their implications. Documents to be reviewed are transmitted to the ERT Chair for distribution to members. ERT comments are consolidated and transmitted to the project. To assure transparency, disposition of ERT comments, observations, or recommendations are documented by the project. Dispositions are shared with the WTP Project Director, the WTP Federal Project Director, and the ERT Chair. ERT review comments and resolution will be included with the deliverable transmittals to the DNFSB. The Chair reviews the disposition of comments with the ERT members and provides documentation of ERT agreement.

The ERT scope will be expanded to include Tank Farm feed delivery activities and cross-cutting gap analysis.

Key deliverables that will be generated as part of development of the LSIT program include:

- 24590-WTP-RPT-ENG-10-001, Integrated Pulse Jet Mixed Design and Control Strategy (Commitment 5.1.3.1)
- Issue written responses to recommendations from key stakeholders (Commitment 5.1.3.2)
- Documentation of CRESP and PNNL acceptance of recommendation dispositions (Commitment 5.1.3.3)

The LSIT will use simulants based on the full range of Hanford tank farm HLW physical and rheological properties to establish performance limits for the PJM mixing, sampling, and transfer systems to safely mix and transfer tank waste. Simulant development is further addressed in Section 5.2.

Results from the LSIT will be used in conjunction with tank waste retrieval, staging, characterization, and transfer system performance information to update the WAC for WTP. An assessment will be completed to determine if engineered features are required to segregate or condition waste that may not meet the WAC (Commitment 5.5.3.9).

DOE will address the principal safety issues as follows:

1. **Criticality Safety.** Update the CSER to address the emerging information related to PuO2, particle size, particle size distribution, and density (Commitment 5.1.3.4). Define functional requirements for mixing, sampling, transfer, and heel management systems required for criticality safety (Commitment 5.1.3.5). Develop test plans including tests necessary to support assessment of criticality safety (Commitment 5.1.3.6). Tests will evaluate the mixing and transfer of fissile and large particulate surrogates at multiple scales by measuring accumulation over multiple batches. The results will be used to address potential accumulation of fissile materials in vessel heels and the impact for preferential removal of larger particles during heel management operations. Complete an analysis documenting the conclusions regarding the capability of PJM mixing, sampling, transfer, and heel management systems to perform their criticality safety functions (Commitment 5.1.3.7).
2. **Retention of Flammable Gas.** Document requirements for release of flammable gas (Commitment 5.1.3.5). Define test requirements to demonstrate mixing necessary to

release flammable gas (Commitment 5.1.3.6). The simulant used for this testing would be based on heel characteristics resulting from multi-batch accumulation unless accumulation is shown to be precluded. Tests will be conducted at multiple scales. Tests also will study re-mobilization of solids after vessel contents are allowed to settle, which represents abnormal and accident conditions that might disrupt the PJM operation (Commitment 5.1.3.6). Complete an analysis documenting the conclusion regarding the capability of PJM mixing, sampling, transfer, and heel management systems to meet requirements for retention and release of flammable gas (Commitment 5.1.3.7).

3. **Level Instrumentation and Control.** Tests in a full-scale, single PJM test rig that has prototypic controls and prototypic system operating conditions, and the 14 foot large scale test vessel also with prototypic level instrumentation and PJM controls will evaluate instrumentation accuracy and PJM control. The tests will collect data to assess the ability of the systems to control the PJMs, determine bubbler performance, develop criterion for heel removal, and prevent overblow conditions over a range of simulants and vessel operating conditions. Tests in the two vessels will also collect data on the accuracy of level indication to support safety and operational needs at varying vessel levels and with different waste characteristics, including solids gradients. Requirements for PJM level instrumentation and control performance will be documented (Commitment 5.1.3.5). A test plan to perform vessel level instrumentation and PJM control testing including testing objectives will be prepared (Commitment 5.1.3.6). Criteria to assess the need to test level and instrumentation control in different vessel arrangements or at different scales will be prepared (Commitment (5.1.3.8). A report will be prepared addressing the use of data to predict level and instrumentation control in different vessel arrangements at different vessel sizes in the design. The report will include an assessment of the need for testing additional configurations and additional vessel scales (Commitment 5.1.3.9). An analysis will be completed documenting the conclusions regarding the capability of PJM level instrumentation and control to perform their functions (Commitment 5.1.3.7).

The LSIT test plan will establish the technical basis for each part of the testing (Commitment 5.1.3.6). Criteria for review and interpretation of the LSIT results will be developed consistent with test objectives (Commitment 5.1.3.6). Key documents that will provide the technical basis for the LSIT include the following:

- **Documented Test Objectives.** Engineering testing needs will be described in 24590-WTP-RPT-ENG-10-001, *Integrated Pulse Jet Mixed Vessel Design and Control Strategy*, and amplified in requests for technology development (RTDs) to define information needs and describe how the data is to be used, including review and interpretation of data and testing results (Commitment 5.1.3.10). Test objectives include but are not limited to scaling, shearing of waste, vessel bottom phenomena, accumulation, performance testing, heel management, sampling, etc. Testing objectives are defined at a high level in the strategy document (24590-WTP-RPT-ENG-10-001) with flowdown to and progressively more detail in RTDs (Commitment 5.1.3.10), followed by test specifications (Commitment 5.1.3.12), and finally, test plans (Commitment 5.1.3.6).

- **Construction Specification.** Specifications for the 14 ft integrated test platform will be completed to ensure prototypic mixing systems, including PJM control, tank-level instrumentation systems, sampling systems, and transfer systems are fabricated to recognized engineering standards and applicable quality assurance requirements (Commitment 5.3.1.11).

- **Test Specifications.** Test specifications will be prepared that define test methods, tests, requirements for valid testing, operating ranges, data collection goals and methods, and quality assurance criteria (Commitment 5.1.3.12).

- **Simulant Basis Documents.** Safety basis documents documenting the basis for design of simulants with the basis for simulant validation (Commitment 5.2.3.1 and 5.2.3.2).

- **Scaling Basis.** The scaling basis will define the basis for less-than-full-scale testing, including vessel configurations, operating parameters, and simulant parameters. The basis for scaling the various parameters (e.g., PJM and vessel geometry, PJM discharge velocity, PJM nozzle diameter, pump suction line diameter, etc.) for the tests to conducted in the program will be addressed (Commitment 5.1.3.13).

- **Vessel Configurations for Testing.** Establishing the basis for selection of specific test configurations for testing relative to assessing and establishing mixing capabilities and process limits across the range of WTP vessels (e.g., mixing power, contents, PJM configuration) (Commitment 5.1.3.14).

The LSIT will use 43-in. (commonly referred to as 4-ft), 8-ft, and 14-ft scales, as well as a nominal 6-ft diameter vessel that can accommodate a single full scale PJM. A decision point is included in the IP to assess the need for testing in vessels larger than 14-ft in diameter (Commitment 5.1.3.15). Technical criteria that will be used to make the decision will be developed and a technical justification will be provided that will support the decision (Commitment 5.1.3.15).

Multiple vessel configurations will be tested and will include vessels that are essentially full-scale at 14-ft (RLD-VSL-00008 and UFP-VSL-00002), as well as those that are the lowest "powered" high solids vessels in the Newtonian (distributed array) class (HLP-VSL-00022) and the non-Newtonian (clustered array) class of vessels (HLP-VSL-00027). These vessel tests will be conducted with integrated operation of fully prototypic mixing, transfer, and sampling systems in all planned operational configurations (e.g., simultaneous operation, gravity refill, restart, PJM maintenance). The determination of the need to test larger vessels will be assessed based on success and confidence achieved in predictions of performance in the 14-ft test vessel (Commitment 5.1.3.15). Testing of heel management and sampling systems is discussed in Sub-recommendations 6 and 4 respectively.

Waste simulants will be developed for mixing and transfer system testing that reflect the physical and rheological properties of HLW stored in the Hanford tank farms. The basis for the simulant design will be documented as described in the Section 5.2. Multiple simulants will be developed to address specific test objectives, considering the range of waste characteristics that impact mixing (e.g., particle size, particle density, particle shape, fluid density, fluid rheology, slurry

rheology, slurry density). Simulants will include Newtonian and non-Newtonian properties and reflect uncertainties in the existing characterization of the HLW. Simulants also will be developed to determine the limits for safe WTP mixing and transfer system performance.

The testing described in the Sub-Recommendation will be used to inform the design of the non-Newtonian vessels (HLP-00027A/B, HLP-00028, and UFP-00002A/B) and support a decision to place the vessels in the Pretreatment facility. Information will also inform the design verification activities required on all PJM mixed vessels. Documentation of the decision to place the non-Newtonian vessels in the Pretreatment facility, and documentation for design verification of all PJM mixed vessels will describe how this information was used.

Placement of the non-Newtonian vessels is on the critical path to complete Pretreatment and, therefore, on the project critical path to begin treating high level tank waste. For placement to take place, high confidence is required that the vessels will meet their mixing performance requirements. To develop this confidence a variety of actions are planned, including testing in the large-scale 8-ft vessel (1/2 to 1/3 the diameter of the non-Newtonian vessels) to demonstrate performance, specifically for the safety functions of hydrogen gas release and no solids accumulation. Testing in the 8-foot vessel will also be used to develop added data for the verification and validation (V&V) of CFD (see Section 5.3).

The initial focus of the planned activities, including the large-scale testing, is on the performance of the PJM arrays in the non-Newtonian vessels, the so-called “chandelier” arrays. Due to the complex fabrication of these chandelier arrays, modification after vessel placement is problematic; therefore, assurance about their performance is needed before installation. Other design changes, interior or exterior to the non-Newtonian vessels and all Newtonian vessels, can be accomplished all the way through cold commissioning.

5.1.3 Sub-recommendation 1 Commitments

DOE’s implementation milestones for Sub-recommendation 1 are as follows.

Commitment 5.1.3.1	**Issue the Integrated Pulse Jet Mixed Design and Control Strategy**
Primary Resource	BNI
Deliverable	Revision to Integrated Pulse Jet Mixed Design and Control Strategy to incorporate commitments from the 2010-2 IP.
Target Completion Date	August 1, 2012
Commitment 5.1.3.2	**Issue responses to recommendations from key stakeholders**
Primary Resource	BNI

Deliverable	Issue written responses, including plans to address mixing "vulnerabilities" recommendations from PNNL and CRESP Letter Report 7.
Target Completion Date	March 31, 2012
Commitment 5.1.3.3	**Documentation of stakeholder acceptance of recommendation dispositions**
Primary Resource	DOE and BNI
Deliverable	Documentation of CRESP and PNNL acceptance of recommendation dispositions for reviews conducted by CRESP and PNNL.
Target Completion Date	August 1, 2012
Commitment 5.1.3.4	**Update the CSER**
Primary Resource	BNI
Deliverable	Submittal of update the CSER to ORP to address the emerging information related to PuO2.
Target Completion Date	December 31, 2013
Commitment 5.1.3.5	**Define and document functional requirements**
Primary Resource	BNI
Deliverable	Update and where necessary define functional requirements for mixing, sampling, transfer, and heel management systems required for criticality safety. Document requirements for retention and release of flammable gas. Document requirements for PJM control performance. Document requirements for PJM level instrumentation performance.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.6	**Develop test plans**
Primary Resource	BNI

Deliverable	Develop test plans, based on the strategy document, RTDs, and test specifications including: Tests necessary to support assessment of criticality safety; Tests necessary to demonstrate release of flammable gas; Tests to study re-mobilization of solids after vessel contents are allowed to settle, which represents abnormal and accident conditions that might disrupt PJM operation; Tests to study PJM level instrumentation and control performance; Tests to demonstrate integrated operation of prototypic PJM mixing, sampling, control and transfer; Tests to substantiate the conclusion that Newtonian techniques may be used to assess non-Newtonian vessel performance; and Test with 8-ft vessel to provide vessel pumpdown data to support CFD V&V. Test plans will document test objectives. Test plans will include the technical basis for each part of the testing. Test plans will include criteria for review and interpretation of the LSIT results consistent with test objectives. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests.
Commitment 5.1.3.7	**Analysis of test results**
Primary Resource	BNI
Deliverable	Issue reports for testing performed in Commitment 5.1.3.6. Complete analysis documenting the conclusions regarding the capability of PJM mixing, sampling, transfer, and heel management systems to: Perform their criticality safety functions Meet requirements for retention and release of flammable gas Complete analysis documenting the conclusions regarding the capability of PJM level instrumentation and control to perform their functions. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of test series plus nine months

Commitment 5.1.3.8	**Criteria to assess the need to test level instrumentation and PJM control with different arrangement and scale**
Primary Resource	BNI
Deliverable	Prepare criteria to assess the need to test level and instrumentation accuracy and control of PJMs in different vessel arrangements or at different vessel scales.
Target Completion Date	Upon completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, scaling testing, and CFD V&V, plus 8 months.
Commitment 5.1.3.9	**Report addressing extension of PJM level instrumentation and control assessment to different vessel configuration and size**
Primary Resource	BNI
Deliverable	A report will be prepared addressing the use of data to predict level accuracy and PJM control in different vessel arrangement and different vessel sizes. The report will include an assessment of the need for testing additional configurations and additional vessel scales.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, and scaling testing, plus 8 months
Commitment 5.1.3.10	**Documented test objectives**
Primary Resource	BNI
Deliverable	Requests for technology development will be prepared for each series of related tests amplifying the testing needs documented in 24590-WTP-RPT-ENG-10-001. The report will define information needs and describe how the data is to be used, including review and interpretation of data and testing results. Test objectives include but are not limited to scaling, shearing of waste, vessel bottom phenomena, pump-out, performance testing, heel management, sampling, etc. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.11	**Construction Specifications**
Primary Resource	BNI

Deliverable	Specifications for the 14 foot test platform for integrated system testing will be completed to ensure the testing objectives for the platform can be met. For the 14-ft test vessel, this includes prototypic mixing systems, including PJM control, tank-level instrumentation systems, sampling systems, and transfer systems. These systems are fabricated to recognized engineering standards and applicable quality assurance requirements.
Target Completion Date	May 30, 2012
Commitment 5.1.3.12	**Test Specifications**
Primary Resource	BNI
Deliverable	Test specification will be prepared defining test methods, tests, requirements for valid testing, operating ranges, data collection goals and methods, and quality assurance criteria. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, expected to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.13	**Scaling Basis**
Primary Resource	BNI
Deliverable	Defining the basis for less-than-full-scale testing, including vessel configurations, operating parameters, and simulant parameters. The basis for scaling both vessel physical performance and simulant physical performance will be addressed. The scaling basis should address physical scale laws observed in test results and scale laws used to establish operating conditions for testing. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	April 30, 2012
Commitment 5.1.3.14	**Vessel configurations for testing**
Primary Resource	BNI

Deliverable	Documentation of the basis for selection of specific test configurations for testing relative to assessing and establishing mixing capabilities and process limits across the range of WTP vessels (e.g., mixing power, contents, PJM configuration). The documentation shall define the technical basis and requirements for all test configurations and sizes including the 4-ft, 8-ft, 14-ft, and 6-ft single PJM test platform. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	April 30, 2012
Commitment 5.1.3.15	**Decision point on the need for larger scale testing**
Primary Resource	BNI and DOE
Deliverable	An assessment regarding the need to test vessels larger than 14-ft diameter will be issued. The assessment will include technical criteria for the decision and a full technical justification to support the decision. The determination will include assessment of success, uncertainty, margin, and confidence achieved in prediction of performance in the 14-ft test vessel based on empirical testing and CFD. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, scaling testing, and CFD V&V, plus 8 months.

5.2 SUB-RECOMMENDATION 2 – WASTE SIMULANTS

Develop waste simulants for the mixing and transfer systems that envelope the complete range of physical properties for the high-level waste stored in the Hanford Tank Farms. The simulant selection should include stimulants that are representative of the waste's Newtonian and non-Newtonian properties and particle shape, e.g. irregularly shaped simulant particles. The physical properties selected for each simulant must reflect uncertainties in the existing characterization of the high-level wastes.

5.2.1 Issue Description

See discussion in Section 5.1.1.

5.2.2 Resolution Approach

The resolution approach involves the following key activities:

- Defining requirements for simulants
- Development and qualification of simulants
- Conducting internal and external review of simulants

Simulants will be developed to support testing defined in Section 1, 4, and 6 of this Implementation Plan in accordance with 24590-WTP-GPG-RTD-004, *Guideline for Simulant Development, Approval, Validation, and Documentation*. Requirements for simulants will be derived from test plans (Commitments 5.1.3.6, 5.4.3.6, and 5.6.3.6) and documented in simulant basis and simulant qualification documents (Commitment 5.2.3.2).

Newtonian and non-Newtonian waste simulants will be developed and used to define the limits of the WTP mixing and transfer system performance, verify that mixing performance satisfies the vessel's design criteria, and characterize the mixing achieved at multiple test vessel scales. Selection of simulants will follow 24590-WTP-GPG-RTD-004 with the simulant criteria established based upon the specific test objectives and the testing approach specified by the test plans.

Knowledge of tank waste characteristics is based on historical process records and core samples of mostly unmixed solids. The complete range of physical properties for retrieved, blended, and mobilized HLW slurries has not been established. An evaluation of waste that can be transferred to WTP from the Tank Farm will be completed. This analysis will be based on known tank waste physical characteristics coupled with an assessment of waste feed staging and transfer system capabilities. This evaluation will inform the expected physical property range of waste that can be transferred and that must be considered in the evaluation of the limits of WTP mixing and transfer system performance (Commitment 5.5.3.2).

WTP LSIT simulants will be based upon the test objectives, the information developed above, as well as sources such as previous process unit operations testing and analysis. Savannah River National Laboratory (SRNL) will be the lead organization for development of LSIT simulants, with support and review provided by PNNL.

The assessment of simulants will include one or more, but not limited to, the following characteristics that challenge the PJM mixing and transfer systems.

- Proportion of irregularly shaped particles and the degree of irregularity.
- Progressively larger particles.
- Progressively denser particles.
- Progressively higher shear strength that tests the limits of the PJM mixing systems to remobilize waste after it has settled.

- Progressively lower and higher yield stress and consistency (plastic viscosity) simulants for non-Newtonian testing.
- Progressively higher solids loading.
- Progressive variation in the degree of thixotropic and rheopectic properties.

An assessment of physical and chemical properties important to testing and development of mixing scaling relationships will be completed (Commitment 5.2.3.1).

The selected simulant physical and chemical properties (range and variation) and their qualification will be documented in a report (Commitment 5.2.3.2)

The LSIT simulant development program will coordinate with the WRPS simulant team to produce consistent Hanford waste simulation (e.g., testing of staged waste in tank farm and as received waste in WTP). The suite of waste simulants developed will consider chemical as well as physical properties of HLW. BNI Engineering, BNI Nuclear Safety, WRPS staff, and DOE staff will be included in the review process for proposed waste simulants to ensure the simulants meet WTP needs.

The ERT will review test objectives, physical properties important to testing and scaling, proposed requirements for simulants, selected simulants, and simulant qualification. The ERT will document consensus with selected simulants (Commitment 5.2.3.2).

The results from testing and associated uncertainty will be used to develop the WAC; establish the limits of operation for the integrated WTP mixing, transport, and sampling system; and support margin assessments (Commitment 5.7.3.4). The results will also be used to establish future Hanford waste blending or conditioning decisions (Commitment 5.5.3.9).

5.2.3 Sub-recommendation 2 Commitments

DOE's implementation deliverables for Sub-recommendation 2 are as follows.

Commitment 5.2.3.1	**Physical properties important to mixing and scaling**
Primary Resource	BNI
Deliverable	An assessment of physical properties important to testing and development of mixing scaling relationships will be completed. The report will identify the governing properties and associated ranges that need to be addressed to achieve Newtonian and non-Newtonian test objectives.
Target Completion Date	May 1, 2012

Commitment 5.2.3.2	**Qualification reports for simulants**
Primary Resource	BNI
Deliverable	Reports will document the basis for the design of simulants for Newtonian and non-Newtonian LSIT. The selected simulant physical and chemical properties (range and variation) and their qualification will be documented. The ERT will review test objective, physical properties important to testing and scaling, proposed requirements for simulants, selected simulants, and simulant qualification and provide comments. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, expected to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)

5.3 SUB-RECOMMENDATION 3 – MODEL VERIFICATION AND VALIDATION

Complete verification and validation of any computational models used by the WTP project team (e.g., Low Order Accumulation Model and FLUENT) based on the results from the large-scale testing.

5.3.1 Issue Description

Computational fluid dynamics (CFD) is the methodology selected by BNI to confirm that PJM mixing requirements are met in all PJM-mixed vessels. This methodology will undergo a V&V process that ensures the analytical results correctly predict physical system performance. The V&V methodology involves comparing the CFD predictions to test data and performing sensitivity analyses to determine the uncertainty and ultimately the limits of the program. Once verified, the CFD program will be used to analyze PJM mixing performance.

5.3.2 Resolution Approach

The resolution approach involves the following key activities:

- Developing a V&V plan (Issued as 24590-WTP-PL-ENG-11-0002, *The V&V Plan for Computational Fluid Dynamics Modeling of the PJM Vessels for the Hanford Tank Waste Treatment and Immobilization Plant Project*)..
- National Engineering Technology Laboratory (NETL) review of the BNI V&V plan (Issued as 11-WTP-179, *NETL Review of the Bechtel Verification & Validation (V&V) Plan for the Hanford Site*).
- BNI completed an assessment of the use of Newtonian analytical techniques to assess mixing in non-Newtonian vessels (Issued as 24590-WTP-RPT-ENG-11-001, Rev. 0, *Determination that Non-Newtonian Vessels Can Be Evaluated Using Newtonian Techniques*). This report will be updated after completion of testing to further underpin the conclusions in 24590-WTP-RPT-ENG-11-001 (Commitment 5.3.3.1).
- Conducting an external review by NETL and the ERT of BNI report 24590-WTP-RPT-ENG-11-001 concluding non-Newtonian vessel mixing can be assessed using Newtonian techniques (Commitment 5.3.3.2).
- Conducting a data gap analysis assessing data required to complete V&V of CFD for use in assessing PJM mixed vessel performance. BNI has concluded additional vessel pump down data for heel solids concentration will be required (Commitment 5.3.3.4).
- Conducting an external review of the BNI gap analysis of data necessary to complete the V&V of CFD for vessel mixing assessment using NETL (Commitment 5.3.3.5).
- Completing V&V of the CFD software (Commitment 5.3.3.7).
- Conducting external peer review by NETL of the V&V results (Commitment 5.3.3.8).
- Benchmarking the CFD outputs against selected LSIT results (Commitment 5.3.3.11).

BNI has selected ASME V&V 20-2009 as the standard to conduct V&V of the CFD model planned to be used to assess mixing and pumpdown performance in PJM-mixed vessels. The V&V effort discussed here addresses only software used for PJM mixing performance analyses. Subject matter experts from the NETL have completed an evaluation of plans to perform V&V of CFD for PJM mixing. BNI has accepted the NETL comments and recommendations on the V&V plan. BNI has completed an assessment and concluded that near bottom solids mobilization that will be used to assess mixing performance in non-Newtonian vessels can be assessed using Newtonian techniques. This assessment is documented in 24590-WTP-RPT-ENG-11-001. Additional testing is planned to further substantiate this conclusion (Commitment 5.1.3.6 and 5.1.3.7). Report 24590-WTP-RPT-ENG-11-011 will be revised to incorporate the results of this testing (Commitment 5.3.3.1). An independent review of this assessment and conclusion will be performed by the NETL and ERT (Commitment 5.3.3.2). DOE will use this information to support a conclusion regarding the viability of using CFD in the analysis of non-Newtonian vessel performance for non-Newtonian conditions (Commitment 5.3.3.3).

The V&V approach involves review of existing data sets from previous testing for inclusion in the model validation. This review has been referred to as a “gap analysis.” Initial analysis

indicates data sets are not sufficient to complete the validation and additional data will be developed. RTDs, test specifications, and test plans for this testing will be developed (Commitment 5.1.3.6, 5.1.3.10, and 5.1.3.12).

BNI will complete an analysis and specify data sets required to support V&V of CFD (Commitment 5.3.3.4). DOE will use NETL to conduct an independent review of the BNI gap analysis of data sets planned to be used to complete the CFD V&V (Commitment 5.3.3.5). DOE will use this information to support a conclusion regarding the viability of completing CFD V&V prior to obtaining all LSIT data sets (Commitment 5.3.3.6).

BNI will complete the V&V of CFD for assessing PJM vessel mixing performance (Commitment 5.3.3.7). NETL will conduct an external peer review of the completed V&V effort (Commitment 5.3.3.8). BNI and DOE will evaluate whether CFD has the precision required to support design verification of PJM vessel mixing performance (Commitment 5.3.3.9).

CFD PJM benchmarking analyses will be performed for selected large-scale tests in the 14-ft-diameter test vessel to confirm the conclusion that the V&V report can be extended to larger scales. A test specification will be prepared to establish test requirements to support the CFD PJM comparison and benchmarking analysis (Commitment 5.3.3.10). The test specification will include the specific criteria that are used to select the large-scale tests to be assessed. A report will be issued ahead of the comparison analyses to document the CFD analysis that will be compared against LSIT data and to define acceptance criteria (Commitment 5.3.3.11). A report will be prepared documenting results from the comparison of CFD predictions and observed LSIT performance (Commitment 5.3.3.12). Should the CFD output and test results be outside the pre-established criteria range, actions will be taken to resolve the matter.

5.3.3 Sub-recommendation 3 Commitments

DOE's implementation milestones for Sub-recommendation 3 are as follows.

Commitment 5.3.3.1	**Update assessment of use of Newtonian analysis techniques to assess non-Newtonian vessel performance**
Primary Resource	BNI
Deliverable	BNI completed an assessment of the use of Newtonian analytical techniques to assess mixing in non-Newtonian vessels (Issued as 24590-WTP-RPT-ENG-11-001, Rev. 0, *Determination that Non-Newtonian Vessels Can Be Evaluated Using Newtonian Techniques*). This report will be updated after completion of testing to further underpin the conclusions in 24590-WTP-RPT-ENG-11-001.
Target Completion Date	August 31, 2012

Commitment 5.3.3.2	**Independent review of paper concluding non-Newtonian conditions can be assessed using Newtonian techniques**
Primary Resource	DOE, NETL and ERT
Deliverable	BNI has completed an assessment and concluded mixing in non-Newtonian vessels can be assessed using Newtonian techniques. This assessment is documented in 24590-WTP-RPT-ENG-11-001. An independent review of this assessment will be performed by the NETL and ERT. Conclusions from this review will be documented in an independent review report.
Target Completion Date	December 31, 2012
Commitment 5.3.3.3	**Conclusion regarding use of Newtonian techniques to assess non-Newtonian conditions**
Primary Resource	DOE
Deliverable	Use information from the NETL and ERT review to support a conclusion regarding the viability of using CFD in the analysis of non-Newtonian vessel performance for non-Newtonian conditions.
Target Completion Date	February 28, 2013
Commitment 5.3.3.4	**Analysis of data sets required to support CFD V&V**
Primary Resource	BNI
Deliverable	Complete an analysis and specify data sets required to support V&V of CFD, including data from 8-ft LSIT testing.
Target Completion Date	February 1, 2012
Commitment 5.3.3.5	**NETL independent review of data sets to support CFD V&V**
Primary Resource	DOE and NETL
Deliverable	Use NETL to conduct an independent review of the BNI gap analysis of data sets planned to be used to complete the CFD V&V.
Target Completion Date	May 30, 2012

Commitment 5.3.3.6	**Decision on need for LSIT to support CFD V&V**
Primary Resource	DOE
Deliverable	Use information from the NETL review to support a conclusion regarding the viability of completing CFD V&V prior to obtaining additional LSIT data sets beyond those specified in gap analysis.
Target Completion Date	July 31, 2012
Commitment 5.3.3.7	**Compete V&V of CFD**
Primary Resource	BNI
Deliverable	Complete the V&V of CFD for assessing PJM vessel mixing performance
Target Completion Date	October 31, 2012
Commitment 5.3.3.8	**External review of complete V&V of CFD**
Primary Resource	DOE and NETL
Deliverable	NETL will conduct an external peer review of the completed V&V effort and evaluate whether CFD has the precision required to support design verification of PJM vessel mixing performance.
Target Completion Date	Feb 28, 2013
Commitment 5.3.3.9	**Assessment of whether CFD has required precision**
Primary Resource	DOE and BNI
Deliverable	Evaluate whether CFD has the precision required to support design verification of PJM vessel mixing performance.
Target Completion Date	August 31, 2013
Commitment 5.3.3.10	**Data required to support assessment of CFD against LSIT**
Primary Resource	BNI

Deliverable	A test specification will be prepared to establish test requirements to obtain required LSIT data to support the CFD PJM benchmarking analysis. The test specification will include the specific criteria that are used to select the large-scale tests to be assessed.
Target Completion Date	October 31, 2012
Commitment 5.3.3.11	**CFD analysis of planned LSIT**
Primary Resource	BNI
Deliverable	A report will be issued ahead of the comparison analyses to document the CFD analysis that will be compared against 8-ft and 14-ft LSIT data and to define acceptance criteria.
Target Completion Date	August 31, 2013
Commitment 5.3.3.12	**CFD prediction of LSIT performance assessment**
Primary Resource	BNI
Deliverable	A report will be prepared documenting results from the comparison of CFD predictions and observed 8-ft and 14-ft LSIT performance.
Target Completion Date	Completion of reports on selected comparison tests (5.3.3.10), plus 8 months

5.4 SUB-RECOMMENDATION 4 – SAMPLING IN VESSELS

Demonstrate the ability to obtain representative samples of the solids and liquids in all of WTP's vessels, including demonstrating that representative samples can be obtained even if the assumed WTP design particle size or density is exceeded. This will ensure that the sampling system does not exclude large, dense particles and artificially bias the measured particle size and density distribution. The representativeness of these samples must be statistically defensible and meet appropriate confidence limits given the significance of the safety-related issues in the WTP.

5.4.1 Issue Description

Plant sampling requirements necessary for safety purposes and operational control are not finalized. The abilities of the Isolok® sampler equipment to deliver a sample that is

representative of the parameters of interest has not been established, nor is the performance of the equipment and the variability of samples during pulse-mixing operations with rapidly settling particles that will create a solids gradient within the vessel understood.

5.4.2 Resolution Approach

The resolution approach involves the following key activities:

- Establish sampling requirements including requirements necessary for process control and safety (Commitment 5.4.3.1).
- Define testing required to assess sampling system performance (Commitment 5.4.3.6).
- Conduct testing to characterize how the sampling system works and assess sampling system capabilities (Commitment 5.4.3.7 and 5.4.3.8).
- Compare system performance against requirements and determine gaps. Develop solutions for any gaps (Commitment 5.4.3.9).

Currently planned WTP sampling is identified in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD).* Sampling requirements for plant safety and process control require further development. BNI will identify the necessary sample points and utilize a DQO process to assess sources of error, required confidence levels, and analysis methods. This information will be used to define what sampling testing is necessary (Commitment 5.4.3.1).

The following activities will provide information to update existing sampling requirements to address safety and process control requirements. These activities are scheduled to be completed in 2013.

- Criticality sampling requirements will be developed in an updated version of the preliminary CSER. The updated preliminary CSER will address new information about potential plutonium dioxide particle size and quantity in some Hanford tank waste (Commitment 5.4.3.3).
- WTP sampling requirements for process control will be developed based on the principles of the regulatory DQO processes (Commitment 5.4.3.4).
- Hazards analysis of systems will identify sampling needed for maintenance of the safety design basis, particularly in light of new information about waste mixing (Commitment 5.4.3.5).

Testing to obtain data on sampling system performance will be initiated in parallel with completion of the definition of updated sampling requirements. This initial testing will provide system characterization to help focus final testing and minimize delays to sampling issue resolution. This work will begin considering currently planned WTP sampling requirements in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD).* Testing to obtain data on sampling system performance will examine what sampled

media can be gathered by the sampler in terms of pertinent parameters such as particle size, density, shape, and carrier fluid rheology. Initial testing will include non-Newtonian and Newtonian conditions. Initial testing will be performed to determine the range of sample variability.

Testing will also determine how well the sample system performs when sampling particles with size/density beyond the mixing design bases in order to inform operational decisions on batch processing and heel dilution/removal operations. Simulants will be developed to support testing of sampling systems (Commitment 5.2.3.1 and 5.2.3.2). A test plan will be prepared for testing to support assessment of sampling system capability (Commitment 5.4.3.6). Initial testing results will be issued in a report (Commitment 5.4.3.7).

Final testing to assess performance of sampling systems for updated safety and process control sampling requirements will include a demonstration of integrated operation of prototypic PJM mixing, sampling, control, and transfer systems as discussed in the response to Sub-recommendation 1.

Results from integrated testing will be documented in a report (Commitment 5.4.3.8). An assessment of sampling system performance against requirements will be completed. If gaps exist, corrective actions will be taken. Corrective actions may entail design and equipment changes and/or additions or adjustment of sampling requirements. The completed assessment and gap analysis will be documented in a report (Commitment 5.4.3.9).

5.4.3 Sub-recommendation 4 Commitments

DOE's implementation milestones for Sub-recommendation 4 are as follows.

Commitment 5.4.3.1	**Identify sampling requirements to support definition of required sampling system testing**
Primary Resource	BNI
Deliverable	Currently planned WTP sampling is identified in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD).* Sampling requirements for plant safety and process control will be developed as part of commitments 5.4.3.2, 5.4.3.3, 5.4.3.4, and 5.4.3.5. BNI will identify the necessary sample points and utilize a DQO process to assess sources of error, required confidence levels, and analysis methods. This information will be used to define what sampling testing is necessary. The standard to assess sample variability will be documented.

Target Completion Date	December 30, 2013
Commitment 5.4.3.2	**WTP sampling requirement input considering tank farm sampling capability**
Primary Resource	BNI
Deliverable	Data quality requirements for waste feed pre-qualification from tank farms will be developed using a process based on the principles of regulatory DQO processes.
Target Completion Date	September 30, 2012
Commitment 5.4.3.3	**Develop criticality sampling requirements**
Primary Resource	BNI
Deliverable	Criticality sampling requirements will be developed in an updated version of the preliminary CSER. The updated preliminary CSER will address new information about potential plutonium dioxide particle size and quantity in some Hanford tank waste.
Target Completion Date	December 31, 2013
Commitment 5.4.3.4	**WTP process control sampling requirements**
Primary Resource	BNI
Deliverable	WTP sampling requirements for process control will be developed based on the principles of regulatory DQO processes.

Target Completion Date	September 30, 2012
Commitment 5.4.3.5	**Sampling required to maintain safety design basis**
Primary Resource	BNI
Deliverable	Hazards analysis of systems will identify sampling needed for maintenance of the safety design basis, particularly in light of new information about waste mixing.
Target Completion Date	March 30, 2013
Commitment 5.4.3.6	**Sampling system test plan**
Primary Resource	BNI
Deliverable	A test plan will be prepared for testing to support assessment of sampling system capability. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests
Commitment 5.4.3.7	**Initial sampling system test report**
Primary Resource	BNI
Deliverable	Initial testing results will be issued in a report. ERT review comments and resolution will be included with the deliverable transmittal.

Target Completion Date	Completion of initial sampling system test data report, plus 8 months
Commitment 5.4.3.8	**Integrated testing report**
Primary Resource	BNI
Deliverable	Results from integrated testing will be documented in a report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Upon completion of integrated testing data report, plus 8 months
Commitment 5.4.3.9	**Assessment of sampling system performance and gap analysis**
Primary Resource	BNI
Deliverable	An assessment of sampling system performance against requirements will be completed. The assessment will include the capability to meet requirements for process control and safety. The gap analysis will consider uncertainties in the waste projected to be transferred from the tank farm to WTP and the waste being sampled. The gap analysis will identify the analytical techniques necessary to perform the required sampling analysis. If gaps exist, corrective actions will be taken. Corrective actions may entail design and equipment changes and/or additions or adjustment of sampling requirements. The completed assessment and gap analysis will be documented in a report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Upon completion of commitment 5.4.3.8 plus 6 months

5.5 SUB-RECOMMENDATION 5 – REPRESENTATIVE SAMPLES FROM WASTE FEED TANKS

Define the impact on the waste retrieval, feed delivery, and feed certification processes due to any limitations of the WTP mixing and transfer systems, and demonstrate the ability to obtain adequately representative samples from the waste feed tanks to ensure the WTP waste acceptance criteria can be reliably enforced.

5.5.1 Issue Description

The capability to obtain adequately representative samples in the tank farms has not been demonstrated to ensure WTP safety-related criteria are met. The impact WTP mixing and transfer system limitations have on tank farms feed delivery and certification systems has not been fully defined. Controls beyond the current planned tank waste feed staging systems may be required to better characterize, segregate, or condition waste feed to WTP.

5.5.2 Resolution Approach

The resolution approach involves the key activities noted below. Throughout this section, sampling invokes the meaning of "Representative Sample" as specified in the Glossary. Further, the term "Statistically Significant" from that definition will be defined in appropriate DQOs.

Initial Phase

- Define initial requirements for tank waste feed that is transferred between the Hanford tank farms and WTP, referred to as the WAC. This includes requirements to obtain representative samples. This initial set of requirements will be based on current information (Commitment 5.5.3.1).

- Determine the physical characteristics of waste that is expected to be transferred to WTP from the tank farms based on available characterization information and an initial assessment of the planned feed staging and transfer systems (Commitment 5.5.3.2).

- Determine the range of physical properties that can be sampled and characterized based on existing information on tank farm sampling systems (Commitment 5.5.3.1).

- Perform an initial gap analysis to determine if the expected range of waste properties for waste transferred to WTP exceeds the WAC and if the staging tank sampling systems can

detect physical properties important for the WAC and identify waste that may not meet the WAC (Commitment 5.5.3.1).

Second Phase

- Refine the WAC (Commitment 5.5.3.3) based on information developed in Sub-Recommendations:
    - 1 – LSIT to determine the PJM mixed vessel capability to prevent: 1) accumulation of fissile material that could result in criticality; 2) accumulation of flammable gasses that could result in a deflagration or detonation; and 3) accumulation or stratification of solids preventing accurate PJM control and excessive overblows that could exceed structural criteria (Commitment 5.1.3.8).
    - 4 – Sampling capability in PJM mixed vessels to meet safety and process control requirements (Commitment 5.4.3.7, 5.4.3.8, and 5.4.3.9).
    - 6 – Heel management system capability to move waste forward in the process (Commitment 5.6.3.7 and 5.6.3.8).
- Determine the range of waste physical properties that can be retrieved and transferred to WTP based on testing and analysis (Commitment 5.5.3.4, 5.5.3.5, 5.5.3.6, and 5.5.3.7).
- 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 (Commitment 5.5.3.4, 5.5.3.5, 5.5.3.6, and 5.5.3.7).
- Perform a gap analysis to determine if the expected range of waste properties for waste transferred to WTP exceeds the WAC and if the staging tank sampling systems can detect physical properties important for the WAC and identify waste that may not meet the WAC (Commitment 5.5.3.9).

The initial phase of work in this Sub-Recommendation will produce an assessment of gaps between the initial WAC, Tank Farm sampling system capabilities, and waste projected to be transferred to WTP. This assessment will include the activities contained in Commitment 5.5.3.1

The establishment of the WAC will be an iterative process. The initial WAC and associated confidence requirements have been defined in ICD-19, 24590-WTP-RPT-MGT-11-014, *Initial Data Quality Objectives for WTP Feed Acceptance Criteria*, and will be augmented with information developed as part of ongoing and completed assessments and hazard analysis including but not limited to vessel mixing assessments, criticality, hydrogen generation, unit liter dose, etc. While the initial DQO does not represent all finalized requirements and includes action items that need to be addressed, it does provide a starting point to begin identifying gaps in requirements and system capabilities.

Tank waste planned for delivery to WTP is staged in double-shell tanks (DST) in the Hanford tank farms. Low-Activity Waste (LAW) feed is staged in a DST with provisions to minimize

solids transfer. Specifically, LAW waste is staged in a DST with the mixing system off for a period of time to allow settling of rapid settling solids and decanted from an elevation above the tank bottom to minimize entrainment of solids. HLW feed is delivered from a DST with solids being mixed by two ~300 hp pumps and transferred to WTP with a pump suction point near the tank bottom. The pump is currently designed with a 3/8 inch screen. The range of physical properties for waste that is anticipated to be transferred to WTP over the mission will be defined. This assessment will be based on available characterization information including PNNL-20646 EMSP-RPT-006, *Hanford Waste Physical and Rheological Properties: Data and Gaps*, and the physical capabilities of the retrieval and transfer systems. The performance capabilities of the tank farm staging and transfer systems will be assessed. This assessment will define the full range including the assessment of uncertainty in physical properties including particle size, particle density, and rheology for waste anticipated to be delivered to WTP with the current feed staging and transfer concepts (Commitment 5.5.3.2).

An assessment of the capability of the tank farm staging tank sampling systems to obtain samples that can be used to assess the range of physical properties identified in the initial WAC will be performed. This assessment will include an estimate of waste properties that can be measured and those that cannot be measured based on sampling system limitations.

The tank farms mixing and sampling capabilities are being assessed by the TOC mixing and sampling test program. Work is in progress to understand the mixing and sampling capabilities based on performance from two test scales of DST systems. Results from the initial phase of testing are being analyzed and compared against requirements. This understanding of system performance will continue to evolve as the Small-Scale Mixing Demonstration (SSMD) provides data on tank farm system capabilities.

An initial gap analysis is being performed to determine if the expected range of waste properties for waste transferred to WTP exceeds the initial WAC and if the staging tank sampling systems can detect physical properties that exceed the WAC. Information from this initial gap analysis will be used to define requirements for testing being planned by WRPS for evaluating tank waste feed staging, sampling, and transfer systems and BNI for PJM mixed vessel mixing, sampling, transfer, and PJM control testing. The results may provide insight into the types of potential controls that may be necessary to assure waste delivered to WTP conforms to the WAC.

The second phase of work includes activities leading to the definition of controls that may be needed to assure waste delivered to WTP conforms to the revised WAC. The WAC will be revised (Commitment 5.5.3.3) based on information developed as part of:

- Sub-Recommendation 1 regarding WTP PJM mixed vessel capabilities to prevent accumulation of material that could result in criticality or accumulation of flammable gasses that could result in a deflagration of detonation and accumulation or stratification of solids preventing accurate PMM control that could result in excessive overblows;

- Sub-Recommendation 4 regarding the capability of PJM mixed vessels and their sampling systems to meet safety and process control requirements; and

- Sub-Recommendation 6 regarding the capability of heel management systems to move waste forward in the process to prevent safety issues.

WRPS will conduct testing 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 characterize waste and determine compliance with the WAC. This work will include identification of test requirements to be documented in a test requirements document (Commitment 5.5.3.4), definition and qualification of simulants (Commitment 5.5.3.5), development of a test plan (Commitment 5.5.3.6), and documenting test results in a report (Commitment 5.5.3.7). Selection of simulants will follow ASTM C1750-11, Standard Guide for Development, Verification, Validation, and Documentation of Simulated High-level Tank Waste with the simulant criteria established based upon the specific test objectives and the testing approach specified by the test plans.

It is recognized that the baseline tank waste core sampling technique (core and grab samples) may not provide representative samples for demonstrating WTP WAC compliance. As a result an alternative sampling approach using Isolok samplers is being evaluated. The ability to obtain representative samples of slurry from transfer pump discharge lines using Isolok samplers is being tested (RPP-PLAN-48787) using a recirculating flow loop designed to capture a sample volume directly from the slurry flowing through the pipe. The testing is designed to identify the different components of possible sampling errors and assess the viability of sample bottle remote handling systems. Similar to the mixing demonstration, the system is being tested (RPP-PLAN-49858) using multi-component simulants containing a wide spectrum of particle sizes and densities. Additionally, the sampling system simulant includes a range of rheological properties that could be expected for HLW feed. The results of the Isolok and Mechanical handling demonstrations will be documented in a Final RSD Results Report (Commitment 5.5.3.8).

A gap analysis will be completed (Commitment 5.5.3.9). The gap analysis will determine if waste properties for tank waste that can be delivered to WTP exceeds the revised WAC. The gap analysis will assess whether the tank waste staging sampling systems can identify waste that complies and does not comply with the WAC.

Once the testing described above is complete, the gap analysis complete, and closure of open items in the initial DQO are complete, an optimized WTP WAC DQO will be developed to define the final waste acceptance requirements and associated data confidence parameters (Commitment 5.5.3.10).

5.5.3 Sub-recommendation 5 Commitments

DOE's implementation milestones for Sub-recommendation 5 are as follows.

Commitment 5.5.3.1	**Initial gap analysis between WTP WAC and tank farm sampling and transfer capability**
Primary Resource	WRPS and BNI

Deliverable	Complete an initial gap analysis between Tank Farm sampling system capabilities, uncertainties, and waste projected to be transferred to WTP. This report will include: A definition of the initial WAC. A determination of the physical characteristics of waste expected to be transferred to WTP with existing feed staging and transfer systems given the uncertainty associated with tank farm characterization data. A determine of the capability of staging tank sampling system. Identification of the analytical techniques necessary to determine the fraction that could exceed the WAC. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	December 31, 2012
Commitment 5.5.3.2	**Evaluation of waste transferred to WTP**
Primary Resource	WRPS
Deliverable	The range of physical properties for waste that is anticipated to be transferred to WTP over the mission will be defined. This assessment will be based on available characterization information including PNNL-20646 EMSP-RPT-006, *Hanford Waste Physical and Rheological Properties: Data and Gaps*, uncertainties (including sampling and analytical error) in the report, and the physical capabilities of the retrieval and transfer systems. Based on available information this assessment will define the preliminary range of physical properties including particle size, particle density, and rheology for waste anticipated to be delivered to WTP with the current feed staging and transfer concepts. The evaluation will include: • A definition of the retrieval and transfer system. • A description of the means and method for determining the standard uncertainties in characterization data that support the physical capabilities of the retrieval and transfer system. • A determination of the performance capabilities of the retrieval and transfer system.
Target Completion Date	June 30, 2012

Commitment 5.5.3.3	**Update the WAC based on LSIT results**
Primary Resource	BNI
Deliverable	The WAC will be revised, based on information developed as part of: Sub-Recommendation 1 regarding WTP PJM mixed vessel capabilities to prevent accumulation of material that could result in criticality or accumulation of flammable gasses that could result in a deflagration of detonation and accumulation or stratification of solids preventing accurate PMM control that could result in excessive overblows; Sub-Recommendation 4 regarding the capability of PJM mixed vessels and their sampling systems to meet safety and process control requirements; and Sub-Recommendation 6 regarding the capability of heel management systems to move waste forward in the process to prevent safety issues.
Target Completion Date	12 months from completion of final LSIT test report.
Commitment 5.5.3.4	**Identification of tank farm sampling and transfer capability test requirements to be documented in a test requirements document**
Primary Resource	WRPS
Deliverable	This work will include identification of test requirements. Testing will cover the range of physical properties of tank waste expected to be staged, sampled, and transferred including uncertainties. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	January 31, 2012
Commitment 5.5.3.5	**Definition of simulants for tank farm performance testing**
Primary Resource	WRPS
Deliverable	Definition and qualification of simulants for testing to establish tank farm performance capability. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	March 31, 2012

Commitment 5.5.3.6	**Test plan to establish Tank Farm performance capability**
Primary Resource	WRPS
Deliverable	WRPS will conduct testing 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 characterize waste and determine compliance with the WAC. This work will include development of a test plan. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	May 31, 2012
Commitment 5.5.3.7	**Results from Tank Farm performance testing**
Primary Resource	WRPS
Deliverable	Documentation of test results in a report for tank farm performance testing. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	March 31, 2013
Commitment 5.5.3.8	**Issue remote sampler test report**
Primary Resource	WRPS
Deliverable	The results of the Isolok and Mechanical handling tests will be document in a Final RSD Results Report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	December 31, 2012
Commitment 5.5.3.9	**Gap Analysis**
Primary Resource	WRPS and BNI

Deliverable	The gap analysis will determine if waste properties for tank waste that can be delivered to WTP exceeds the revised WAC. The gap analysis will assess whether the tank waste staging sampling systems can identify waste that complies and does not comply with the WAC. The gap analysis will determine if engineered features are required to ensure waste delivered to WTP meets the WAC. The analysis will include identification of • The revised WAC. • Tank Farm sampling system capabilities and uncertainties. Required analytical techniques to characterize waste. The standard to assess sample variability will be documented. • The waste projected to be transferred to WTP given the uncertainty associated with tank farm characterization data. • Gaps between waste that is expected to be transferred and the WTP revised WAC. • Engineering features that may be needed to ensure waste delivered to WTP conforms to the revised WAC. Options for engineered features to address gaps will include the potential scope at both WTP and Tank Farms. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	August 31, 2014
Commitment 5.5.3.10	**Optimized WAC DQO**
Primary Resource	WRPS and BNI
Deliverable	An optimized WTP WAC DQO will be developed to define the final waste acceptance requirements and associated data confidence parameters.
Target Completion Date	May 31, 2015

5.6 SUB-RECOMMENDATION 6 – FUNCTIONAL DESIGN CRITERIA FOR HEEL MANAGEMENT

Establish functional design criteria for the heel dilution, heel pump-out, and visual inspection functions, and demonstrate the capabilities and limits of these systems through the large-scale testing.

5.6.1 Issue Description

Heel management (dilution and removal) features have been added to the WTP design for selected vessels in recognition that periodic heel cleanup may be required. Heel management

differs from normal mixing in that different pumps may be used, PJMs may be operated differently, different vessel levels are involved, and adjustment of waste properties may be made. While heel management systems have been successfully deployed in many applications, the performance capabilities of the heel management systems in WTP have not been established for Hanford waste.

Vessel access ports were initially proposed for 10 vessels to allow contingent access for emergent future needs. Potential needs included visual inspection, sampling, or equipment insertion. Specific requirements for the proposed vessel access ports have not been identified.

5.6.2 Resolution Approach

The resolution approach involves the following key activities:

- Refine functional design criteria for heel management system in PJM mixed vessels (Commitment 5.6.3.1).
- Add heel management system details to the system descriptions (Commitment 5.6.3.3)
- Complete a preliminary hazard analysis of heel management systems (Commitment 5.6.3.4).
- Complete committed design of heel management systems (Commitment 5.6.3.5).
- Develop and qualify simulants to test heel management systems (Commitment 5.2.3.2 and 5.2.3.3).
- Prepare test plan to obtain performance data on heel management systems and define limits of system capability (Commitment 5.6.3.6).
- Prepare test reports documenting results from testing of heel management systems (Commitment 5.6.3.7).
- Complete a gap analysis evaluating heel management system performance against functional design criteria (Commitment 5.6.3.8).

Each of these activities is discussed in more detail below.

Functional design criteria for the heel dilution and heel pump-out will be established (Commitment 5.6.3.1). WTP has completed an evaluation of a heel management system for selected vessels in 24590-WTP-RPT-PET-10-013, *Pretreatment Vessel Heel Dilution/Cleanout Feasibility Study*. The functional specifications were provided in 24590-PTF-RPT-ENG-10-004, *Pretreatment Vessel Heel Dilution/Cleanout Functional Requirements*. These criteria will be updated to include specific solids removal objectives relevant to particle size/density and across the range of initial waste rheology conditions that will exist in PJM-mixed vessels.
The definition of the system design bases will consider inputs from PNNL-20646 ESMP-RTP-006, tank farms evaluations of the most limiting particle that their delivery system is capable of retrieving and sending to WTP (Commitment 5.5.3.2), and results from RPP-RPT-50941-Rev 00, Review of Plutonium Oxide Receipts into Hanford Tank Farms.

BNI will incorporate heel management design changes into the impacted systems (FEP, HLP, and UFP) (Commitment 5.6.3.2). The heel management design will include features such as liquid addition to vessels, lowered pump suction, and pumps that can operate with less head.

BNI will prepare a description of the heel management systems (Commitment 5.6.3.3). The system descriptions will be updated to include the heel management system functions, requirements, description, operations, and maintenance in accordance with project procedures. Impacted system descriptions include:

- FEP (FEP-VSL-00017A/B;
- HLP (HLP-VSL-00022, -00027A/B, -00028; and
- UFP (UFP-VSL-00001A/B, and -00002A/B.

BNI will perform a hazards analysis to integrate nuclear safety requirements into the design of the heel management systems (Commitment 5.6.3.4). The hazards analysis will be performed according to WTP project procedures on the impacted systems once the heel management design changes have been implemented in the design documents. The results from the hazards analyses will be used, as necessary, to finalize the functional requirements for the system and provide required safety criteria.

BNI will complete the design of the heel management systems (Commitment 5.6.3.5). The design of the FEP, HLP, and UFP systems is underway. The design changes resulting from the heel management system will be incorporated into the design per WTP project procedures including incorporation into piping and instrumentation diagrams and design calculations (as needed).

Simulants for testing the heel management systems will be developed and qualified (Commitment 5.2.3.2 and 5.2.3.3). A test plan will be prepared to obtain performance data on heel management systems and define limits of system capability (Commitment 5.6.3.6). Testing will be conducted at three scales as part of the LSIT program to understand performance at progressively larger scales. The testing will be performed under a range of conditions that challenge heel dilution and removal, and will go beyond the design basis conditions to identify the ultimate limits of the system performance. The heel management process involves several operational variables. The testing will evaluate the range of those operational variables by adjusting the weight percent of the solids, adjusting carrier fluid viscosity, adjusting vessel levels, and operating the pulse jet mixers in different sequences. To the extent that normal mixing system operation may result in local solids accumulation (e.g., “batwings”), those conditions will be replicated to determine performance in those circumstances. Test reports will be issued documenting results from testing of heel management systems (Commitment 5.6.3.7).

A gap analysis will be completed evaluating heel management system performance against functional design criteria (Commitment 5.6.3.8). Design changes will be implemented if performance measured against safety and design margins are not acceptable.

Criteria for assessing the need to install heel management systems in WTP PJM mixed vessels will be established. An assessment of the need for heel management systems in Feed Receipt

Process, Radioactive Liquid Discharge, and Plant Wash Drain vessel will be completed (Commitment 5.6.3.9).

5.6.3 Sub-recommendation 6 Commitments

DOE's implementation milestones for Sub-recommendation 6 are as follows.

Commitment 5.6.3.1	**Define functional design criteria for heel management system**
Primary Resource	BNI
Deliverable	Functional design criteria and performance capabilities of the heel dilution, heel pump-out, and use of the access ports will be established. WTP has completed an initial evaluation of a heel management system for selected vessels in 24590-WTP-RPT-PET-10-013, *Pretreatment Vessel Heel Dilution/Cleanout Feasibility Study*. The initial functional specifications were provided in 24590-PTF-RPT-ENG-10-004, *Pretreatment Vessel Heel Dilution/Cleanout Functional Requirements*. These requirements will be updated to include specific solids removal objectives relevant to particle size/density and across the range of initial waste rheology conditions that will exist in PJM-mixed vessels.
Target Completion Date	March 31, 2012
Commitment 5.6.3.2	**Heel management system design**
Primary Resource	BNI
Deliverable	BNI will incorporate heel management system design changes into FEP, HLP, and UFP designs. The design will include features such as liquid addition to vessels, lowered pump suction, and pumps that can operate with less head.
Target Completion Date	May 30, 2012
Commitment 5.6.3.3	**Heel Management System Description**
Primary Resource	BNI
Deliverable	BNI will update System Descriptions to include the heel management systems functions, description, operations, and maintenance.

Target Completion Date	November 30, 2012
Commitment 5.6.3.4	**Heel Management System hazard analysis**
Primary Resource	BNI
Deliverable	BNI will perform a hazards analysis to integrate nuclear safety requirements into the design of the heel management systems. The hazards analysis will be used to finalize the functional requirements for the system and provide required safety criteria.
Target Completion Date	March 30, 2013
Commitment 5.6.3.5	**Heel Management System committed design**
Primary Resource	BNI
Deliverable	BNI will complete the committed design of the heel management systems incorporated into the FEP, HLP, and UFP systems.
Target Completion Date	1 year after completion of Heel Management test report (5.6.3.7)
Commitment 5.6.3.6	**Heel Management test plan**
Primary Resource	BNI
Deliverable	A Test plan will be prepared to obtain performance data on heel management systems and define limits of system capability. Testing will be conducted at three scales as part of the LSIT program to understand performance at progressively larger scales. The testing will be performed under a range of conditions that challenge heel dilution and removal, and will go beyond the design basis conditions to identify the ultimate limits of the system performance. The heel management process involves several operational variables. The testing will evaluate the range of those operational variables by adjusting the weight percent of the solids, adjusting carrier fluid viscosity, chemical additions, adjusting vessel levels, and operating the pulse jet mixers in different sequences. To the extent that normal mixing system operation may result in local solids accumulation (e.g., “batwings”), those conditions will be replicated to determine performance in those circumstances. ERT review comments and resolution will be included with the deliverable transmittal.

Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests (see 5.1.3.6)
Commitment 5.6.3.7	**Heel Management test report**
Primary Resource	BNI
Deliverable	Test reports will be issued documenting results from testing of heel management systems. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of test series plus nine months (see 5.1.3.7)
Commitment 5.6.3.8	**Heel Management performance gap analysis**
Primary Resource	BNI
Deliverable	A gap analysis will be completed evaluating heel management system performance against functional design criteria. Design changes will be implemented if performance measured against safety and design margins are not acceptable. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of Heel Management test report (5.6.3.7) plus 6 months
Commitment 5.6.3.9	**Assessment of Need for Heel Management in Additional Vessels**
Primary Resource	BNI
Deliverable	Criteria for assessing the need to install heel management systems in WTP PJM mixed vessels will be established. As assessment of the need for heel management systems in Feed Receipt Process, Radioactive Liquid Discharge, and Plant Wash Drain vessel will be completed
Target Completion Date	Completion of Heel Management test report (5.6.3.7) plus 6 months

5.7 SUB-RECOMMENDATION 7 – TECHNICAL AND SAFETY-RELATED RISKS

Identify the technical and safety-related risks that remain unresolved upon completion of the large-scale testing and establish suitable risk management strategies to ensure that each remaining risk will have little, if any, potential impact on DOE's ability to begin WTP operations safely and consistent with existing commitments.

5.7.1 Issue Description

Some technical and safety-related risks may not be fully addressed during LSIT or prior to completion of this IP due to the underlying cause presented in Section 2.1. Limitations due to the volume of HLW samples (e.g., ~450 liters to represent 53 million gallons) and associated uncertainties in the tank waste characterization will continue to be addressed throughout the testing, commissioning, and mission as waste is retrieved, staged, characterized, and feed pre-qualification testing is completed. New technical or safety risks may also be identified based on identified limitations during testing with simulants and other factors that could emerge during LSIT. To manage these risks, DOE will strengthen its program for technical and safety issue identification and resolution, that will facilitate resolution that addresses both the Hanford tank farms and the WTP technical and safety risks (Commitment 5.7.3.2).

5.7.2 Resolution Approach

Resolution of technical and safety-related risks will require activities that are cross-cutting between the Hanford tank farms and WTP. Some will be completed as part of this IP; others will be ongoing throughout the project lifecycle for WTP and mission lifecycle for both the Hanford tank farms and the WTP facilities. Resolution of this sub-recommendation will strengthen DOE's processes needed to resolve known interface issues, manage emerging issues, and consistently provide solutions that integrate nuclear safety and design across the tank farms/WTP boundary. In addition to commitments to strengthen these core processes, this sub-recommendation includes a commitment to evaluate the performance of these processes to facilitate closure of this sub-recommendation (Commitment 5.7.3.3).

The integration of nuclear safety into the design is an ongoing interactive process that takes the results of the hazards and accident analysis to select controls and identify functional requirements that need to be incorporated into the design to ensure that the selected controls will perform their intended safety function. As the design matures, the process compares design media to established safety functions and functional requirements. If there are issues with a selected control providing either the credited safety function or functional requirements, the process is reiterated (as needed) based on the technical or safety issue requiring resolution.

The key elements that will be addressed by DOE to address Sub-recommendation 7 are summarized below.

- Establish the plan and schedule to systematically evaluate the hazards of known technical issues, M3 vessel assessment summary reports, LOAM benchmark data, and LSIT results (Commitment 5.7.3.1). The systematic evaluation of hazards will support updates to WTP accident analysis and control decisions that integrates nuclear safety and design for PTF.

- Strengthen the Interface Management Program to better identify, manage, and resolve technical and safety risks. This program will enhance the existing tank farms-WTP interface issue resolution processes by strengthening roles, responsibilities, authorities and accountabilities and establishing decision making tools for managing emerging technical and safety issues. In addition, it will surface and assist in resolution of contract misalignments as discussed in Section 2.2 (Commitments 5.7.3.2 and 5.7.3.5).

- Evaluate the closure documentation for each sub-recommendation to verify that the results can be implemented in the Hanford tank farms or the WTP, identify any unverified assumptions that could result in a technical or safety risk, and establish the plan and schedule to integrate the results of LSIT into the design and nuclear safety basis documents. This element will be accomplished using the updated interface control program.

- Establish the initial nuclear safety parameters required to be included in the WAC. These parameters will be based on inputs and assumptions to the current hazards and accident analyses (e.g., unit liter dose), inputs and assumptions from engineering documents providing the technical basis for the performance of mixing, transport, and sampling structures, systems, and components, and an updated CSER (Commitment 5.7.3.4).

Issues and risks identified, being managed, and closed in the process of conducting work to close DNFSB Recommendation 2010-2 will be reported in quarterly reports to the DNFSB (Commitment 6.3.1). Technical and safety-related risks that remain unresolved upon completion of the LSIT and other 2010-2 IP work will have suitable risk management strategies to ensure each remaining risk will have little, if any, potential impact on DOE's ability to safely begin WTP operations.

5.7.3 Sub-recommendation 7 Commitments

DOE implementation milestones for Sub-recommendation 7 are as follows.

Commitment 5.7.3.1	**Establish the plan and schedule to systematically evaluate the hazards of known technical issues, M3 vessel assessment summary reports, LOAM benchmark data, and LSIT results.**
Primary Resource:	BNI
Deliverable:	An approved plan that establishes the key activities and schedule to systematically evaluate the hazards and resolve known technical issues and evaluate the results of testing to provide the technical basis to integrate nuclear safety into the Pretreatment Facility design and develop a documented safety analysis that supports commissioning and operations. The plan shall be iterative and develop and validate requirements. The plan shall maintain alignment between design and the safety basis.
Target Completion Date:	January 30, 2012 and updated no less than annually until closure of the IP.
Commitment 5.7.3.2	**Strengthen our Interface Management Program to improve the integrated management of the technical and safety risks in WTP and the tank farms.**
Primary Resource:	DOE
Deliverable:	An updated Interface Management Program Plan that strengthens roles, responsibilities, authorities, and accountabilities for identifying, tracking, managing, and allocating the technical and safety-related risks that span the tank farms/WTP interface and includes a disciplined process to systematically evaluate items to determine their impact on design (i.e., functional and performance requirements) and nuclear safety (i.e., safety bases documents).
Target Completion Date:	July 25, 2012

Commitment 5.7.3.3	**Evaluate the closure document for each sub-recommendation to verify that the results can be implemented in the Hanford tank farms or the WTP.**
Primary Resource:	DOE
Deliverable:	A report will be issued for each sub-recommendation closure documentation review. The report will document the scope of the review, provide objective evidence that the results of the LSIT can be implemented in the Hanford tank farms or WTP, or a plan and schedule to update resolve the technical or safety-related risk and integrate the solution into nuclear safety and the design.
Target Completion Date:	May 9, 2016
Commitment 5.7.3.4	**Identify key inputs, assumptions, safety margin uncertainties, and nuclear safety parameters required to be included in the waste acceptance criteria.**
Primary Resource	BNI
Deliverable:	Report documenting the current nuclear safety parameters that must be included in the WAC. The report will identify the analytical capabilities required to identify waste that exceeds the WAC. If there are changes to the current WAC established in ICD-19, the deliverable will also include the required changes to the ICD.
Target Completion Date:	January 15, 2012
Commitment 5.7.3.5	**Conduct an independent review of the Interface Management Programs strengthened under Commitment 5.7.3.2 to evaluate the effectiveness of the program and implementing procedures and verify that technical and safety-related issues are being identified, evaluated, and tracked to closure.**
Primary Resource	DOE Headquarters
Deliverable:	Independent Assessment Report
Target Completion Date:	January 30, 2013

6.0 ORGANIZATION AND MANAGEMENT

6.1 ORGANIZATION

Overall execution of this IP is the responsibility of the WTP Federal Project Director. An IP core team of staff and managers from EM and the ORP has been established to track the status of the deliverables in the plan and inform the DNFSB of emergent issues.

6.2 CHANGE CONTROL

Complex, long-range plans require sufficient flexibility to accommodate changes in commitments, actions, or completion dates that may be necessary due to additional information, improvements, or changes in baseline assumptions. DOE's policy is to:

1. Provide prior, written notification to DNFSB on the status of any IP commitment that will not be completed by the planned milestone date.

2. Have the Secretary approve all significant revisions to the scope and schedule of plan commitments.

3. Clearly identify and describe the revisions and bases for the revisions.

Fundamental changes to the plan's strategy, scope, or schedule will be provided to DNFSB through formal revision and reissuance of the IP. Other changes to the scope or schedule of planned commitments will be formally submitted in appropriate correspondence approved by the Secretary, along with the bases for the changes and appropriate corrective actions.

6.3 REPORTING

To ensure that the various DOE implementing elements and DNFSB remain informed of the status of plan implementation, DOE policy is to provide periodic progress reports until IP commitments are completed. For this plan, DOE will provide quarterly briefings to DNFSB and/or its staff, within one month of the close of each quarter during plan implementation.

Documents prepared as part of commitments will be transmitted from the WTP Federal Project Director to the DNFSB. A number of commitments in this plan are completed 15 days prior to a follow-on action such as completion of a test plan 15 days prior to initiating a test. These include Commitments 5.1.3.5, 5.1.3.6, 5.1.3.10, 5.2.3.2, 5.4.3.6, and 5.6.3.6. These commitments will be electronically transmitted to the DNFSB Staff when they are completed. Transmittal of these commitments will be documented formally in quarterly progress reports and will be presented to the DNFSB (Commitment 6.3.1).

Progress reports will be used to report minor schedule variances to plan commitments (if needed). These progress reports will not make changes to planned commitment dates, unless approved by the Secretary. The report of a schedule variance will acknowledge that the commitment is overdue, and provide current status information and DOE recovery plans (if needed).

Commitment 6.3.1	**DOE will provide quarterly progress reports and briefings to the DNFSB and DNFSB staff, including updates on the status of completing actions identified in this IP.**
Primary Resource	DOE-WTP
Deliverable:	Quarterly reports and status briefings on the completion of IP milestones and deliverables. Issues and risks identified, being managed, and closed in the process of conducting work to close DNFSB Recommendation 2010-2 will be reported. The report will identify all commitments delivered in the reporting period.
Target Completion Date:	Quarterly beginning January 2012 until the final milestone is completed.

Following completion of the final milestone, DOE will provide progress reports to the DNFSB and DNFSB staff approximately every year until the completion of WTP commissioning and completion of tank farms upgrades.

6.4 QUALITY ASSURANCE

ORP work performed under this plan will be in accordance with MGT-MP-PL-04, *Quality Assurance Program Description*, Revision 1, dated June 19, 2009. BNI work is performed in accordance with 24590-WTP-QAM-QA-06-001, *Quality Assurance Manual*, Revision 8, dated January 14, 2011. The WRPS work is performed in accordance with TFC-PLN-02, *Quality Assurance Program Description*, Revision G, dated February 23, 2011.

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APPENDIX A

GLOSSARY

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APPENDIX A

GLOSSARY

Acceptance criteria – Pre-established standards or requirements a product or project must meet.

Assumption – A statement upon which a design or test strategy is premised whose truth must be verified before the completed design or the test results can be accepted for use.

Authorization bases – The collection of key documents (e.g., safety bases, technical safety requirements, *National Environmental Policy Act* documentation, including environmental impact statements, and environmental permits) that provide the basis for DOE approval to perform the work and the basis for its conclusion that the work defined in the authorization agreement can be performed without undue risk to the workers, the public, and the environment (DOE G 450.4-1B derived).

Consistent with existing commitments – This term is used to describe whether a term/action is considered new or already enveloped by previously made commitments.

Documented safety analysis – A documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety (10 CFR 830.3(a)).

Design verification – A review of final designs (generally prior to procurement or construction) to ensure permanent structures, systems, and components are adequately designed and the designs are properly integrated. Methods of verification include design reviews, qualification testing, alternate calculations, or other approaches.

Data quality objective (DQO) – processes tailored for the Waste Treatment and Immobilization Plant (WTP) that are adapted from the U.S. Environmental Protection Agency (EPA) regulatory DQO process described in EPA QA/G-4, *Guidance for the Data Quality Objectives Process*. EPA QA/G-4 describes a process to develop performance and acceptance criteria (or data quality objectives) that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support EPA regulatory decisions. WTP tailors this process to establish quality and quantity of data needs for analogous decisions that are outside the EPA regulatory sphere.

The joint Washington River Protection Solutions, LLC (WRPS) and WTP DQO team selected the Hanford Site procedure (TFC-ENG-CHEM–C-16, *Data Quality Objectives for Sampling and Analysis*) as the basis for developing the WTP waste acceptance criteria (WAC) DQO. The final process used by the team is described in Section 1.0 of the DQO report, 24590-WTP-RPT-MGT-11-014, *Initial Data Quality Objectives for WTP Feed Acceptance Criteria*, Rev 0. The following DOE and EPA documents are implemented in this process, which invokes specification of tolerable levels of potential decision areas:

- 94-ASB-086, *Institutionalizing the Data Quality Objectives (DQO) Process for the Office of Environmental Management's (EM) Environmental Data Collection Activities;*
- *Hanford Federal Facility Agreement and Consent Order;* and

- EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4).*

Functional design criteria – Design requirements that establish characteristics of components and their support systems required by authorization basis documentation (e.g., preliminary documented safety analysis, safety requirements document, criticality safety evaluation report) ensuring those components are capable of performing their intended safety function when called upon.

Functional requirements – Requirements that are specifically needed to fulfill safety functions for safety significant and needed to support safety-significant structures, systems, and components. Limit functional requirement designations to those requirements necessary for the safety function. (DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*).

Heel management – The process of adjusting the contents of a vessel heel (the volume below the normal operating low liquid level in the vessel), particularly as it relates to removal of solids in the heel. Heel management includes heel dilution, heel removal, and heel cleanout. Heel dilution is performed to reduce the solids concentration in a vessel heel by adding a diluent, operating the pulse jet mixers to mix the vessel, and pumping the slurry out of the vessel down to the normal low level. Heel removal involves pumping the vessel to a level lower than the normal low level, without adding a diluent. Heel cleanout may refer either to heel dilution or heel removal.

Safety basis approval strategy - DOE's overall strategy to align the safety basis documents from the Hanford tank farm facilities and the WTP facilities and ensure that the documents prepared adequately implement nuclear safety into the design and contain hazard controls and commitments that are implementable in the respective nuclear facility. The overall goal of the successful safety basis approval strategy is to provide the integrated set of safety basis documents that support retrieval of waste in the Hanford Tank Farms, transport of the waste to WTP facilities, and successful processing for final disposition.

Margin of safety – The range between two conditions. The first is the most adverse condition estimated or calculated in safety analyses to occur from an operational upset or family of related upsets. The second condition is the worst-case value known to be safe, from an engineering perspective. This value would be expected to be related to the condition at which some accident prevention or mitigation action is taken in response to the upset or accident, not the actual predicted failure point of some component (DOE G.424.1-1B).

Mixed adequately –Describes a tank mixing condition where the distribution of solid particulates within the volume of the tank is sufficient to allow the tank sampling and transfer systems to perform their respective functions while maintaining tank contents within applicable technical safety requirements.

Performance limits – Performance limits are the maximum system capabilities, which, if exceeded, can create a hazardous condition and/or damage the facility and/or cause the system to fail to meet its intended purpose.

Reliably enforced – Achieves the confidence levels required for WTP waste acceptance.

Representative sample – A sample collected in such a manner that it reflects one or more characteristics of interest (as defined by the project objectives) of a population from which it is collected.

This definition is included in:

> ASTM D 5956-96 (Reapproved 2006), *Standard Guide for Sampling Strategies for Heterogeneuous Wastes,* ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428, Para 2.1.15; and
>
> ASTM D 6044-96 (Reapproved 2009), *Standard Guide for Representative Sampling for Management of Waste and Contaminated Media,* ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428, para. 3.14.

Safety bases – The documented safety analysis and hazard controls that provide reasonable assurance that a DOE nuclear facility can be operated safely in a manner that adequately protects workers, the public, and the environment (10 CFR 830.3).

Safety-related risks – The set of issues or risks that, if not resolved, would impact the DOE-approved safety basis.

Scaling – A method by which measurements or observations made at one scale can be duplicated in another scale, either larger or smaller. Scaling is often used in fluid dynamics applications, such as mixing, because complicated geometry and multiple mechanisms make analytical solutions impractical. A critical consideration in testing is geometric similarity because geometry effects are often impossible to predict. Thus, when scaling is used, geometric similarity needs to be followed as closely as possible. Differences in geometry should not be accepted without careful analysis and expert consultation on the potential effect on process results.

The tasks in scaling include:

- Defining the desired process result, because different results may scale differently.
- Testing a range of conditions that allow for the observation of how physical properties affect the process results.
- Establishing the controlling properties for the process of interest.
- Testing on multiple scales are necessary to decide how the process changes with scale, but the relationship should be the same as that observed in similar systems.
- Applying the appropriate scaling methods to the desired process results.

In WTP testing, vessels are in the late stages of construction, so scaling is usually done as scale-down to demonstrate the process performance of the existing designs. (Adapted from *Handbook of Industrial Mixing*, Section 6-4, Scale-up and Section 10-5.2, Process Scale-up).

Simulant – A combination of solid particles in a fluid selected to mimic key expected or projected Hanford waste properties.

Specific administrative control – Limits on operating parameters imposed to provide a specific preventive or mitigative function for postulated accident scenarios identified in the documented safety analysis where the safety function has importance similar to, or the same as, the safety

function of a safety structure, system, or component (e.g., a requirement to employ heel management techniques to limit accumulation of particles in high solids-containing wastes).

Technical risks – The set of issues or risks related to the design or performance of structures, systems or components (SSC) or process issues. SSCs are not limited safety SSCs.

Technical Safety Requirement (TSR) – Controls, limits, and conditions for operation as defined by the performance requirements of structures, systems, and components. TSRs identify the safety management programs used by personnel to ensure safety and are aimed at confirming the ability of the SSCs and personnel to perform their intended safety functions under normal, abnormal, and accident conditions. These requirements are identified through hazard analysis of the activities to be performed and identification of the potential sources of safety issues. Safety analyses to identify and analyze a set of bounding accidents that take into account all potential causes of releases of radioactivity also contribute to development of TSRs.

Verification and Validation (V&V) – The process of checking that a product, service, or system – in this case a computational fluid dynamics model – meets specifications and that it fulfills its intended purpose. Verification establishes the numerical accuracy of the model, first by verifying that the computer code is correct and passes convergence tests, then by verifying the solution. Solution verification involves error estimation because the exact solution to the specific problem is unknown. Validation is a process of comparing the model output with experimental measurements of the flow being modeled to discover the range of simulation modeling error.

Waste acceptance criteria – Those requirements that are to be met for staged waste prior to transfer to the next position (e.g., transfer to the WTP from the Hanford tank farm).

Zone of influence – The volume within which a pulse jet mixer or other device enhances mixing.

ATTACHMENT B

2010-2 Commitment List

Commitment 5.0.1	**Safety Basis Approval Strategy Document**
Primary Resource:	BNI and WRPS
Deliverable:	Develop a safety basis approval strategy to ensure that the safety basis documents for the Hanford tank farms and the safety basis documents for WTP facilities provide an integrated set of nuclear safety controls that consistently analyze and control hazardous conditions. The integrated strategy will ensure that the WTP can be commissioned and provide a consistent technical basis for the evaluation of emerging issues and maintenance of the safety basis documents.
Target Completion Date:	June 30, 2012
Commitment 5.1.3.1	**Issue the Integrated Pulse Jet Mixed Design and Control Strategy**
Primary Resource	BNI
Deliverable	Revision to Integrated Pulse Jet Mixed Design and Control Strategy to incorporate commitments from the 2010-2 IP
Target Completion Date	August 1, 2012
Commitment 5.1.3.2	**Issue responses to recommendations from key stakeholders**
Primary Resource	BNI
Deliverable	Issue written responses, including plans to address mixing “vulnerabilities” recommendations from PNNL and CRESP Letter Report 7.
Target Completion Date	March 31, 2012
Commitment 5.1.3.3	**Documentation of stakeholder acceptance of recommendation dispositions**
Primary Resource	DOE and BNI

Deliverable	Documentation of stakeholder acceptance of recommendation dispositions for reviews conducted by CRESP and PNNL.
Target Completion Date	August 1, 2012
Commitment 5.1.3.4	**Update the CSER**
Primary Resource	BNI
Deliverable	Submittal of update the CSER to ORP to address the emerging information related to PuO2.
Target Completion Date	December 31, 2013
Commitment 5.1.3.5	**Define and document functional requirements**
Primary Resource	BNI
Deliverable	Update and where necessary define functional requirements for mixing, sampling, transfer, and heel management systems required for criticality safety. Document requirements for retention and release of flammable gas. Document requirements for PJM control performance. Document requirements for PJM level instrumentation performance.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.6	**Develop test plan**
Primary Resource	BNI
Deliverable	Develop test plans, based on the strategy document, RTDs, and test specifications including: • Tests necessary to support assessment of criticality safety • Tests necessary to demonstrate release of flammable gas • Tests to study re-mobilization of solids after vessel contents are allowed to settle, which represents abnormal and accident

	conditions that might disrupt PJM operation • Tests to study PJM level instrumentation and control performance • Tests to demonstrate integrated operation of prototypic PJM mixing, sampling, control and transfer • Tests to substantiate the conclusion that Newtonian techniques may be used to assess non-Newtonian vessel performance. • Test with 8-ft vessel to provide vessel pumpdown data to support CFD V&V. • Test plans will document test objectives. • Test plans will include the technical basis for each part of the testing. • Test plans will include criteria for review and interpretation of the LSIT results consistent with test objectives. • ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests.
Commitment 5.1.3.7	**Analysis of test results**
Primary Resource	BNI
Deliverable	• Issue reports for testing performed in Commitment 5.1.3.6. Complete analysis documenting the conclusions regarding the capability of PJM mixing, sampling, transfer, and heel management systems to: • Perform their criticality safety functions • Meet requirements for retention and release of flammable gas • Complete analysis documenting the conclusions regarding the capability of PJM level instrumentation and control to perform their functions. ERT review comments and resolution will be included with the deliverable transmittal.

Target Completion Date	Completion of test series plus nine months
Commitment 5.1.3.8	**Criteria to assess the need to test level instrumentation and PJM control with different arrangement and scale**
Primary Resource	BNI
Deliverable	Prepare criteria to assess the need to test level and instrumentation accuracy and control of PJMs in different vessel arrangements or at different vessel scales.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, scaling testing, and CFD V&V, plus 8 months.
Commitment 5.1.3.9	**Report addressing extension of PJM level instrumentation and control assessment to different vessel configuration and size**
Primary Resource	BNI
Deliverable	A report will be prepared addressing the use of data to predict level accuracy and PJM control in different vessel arrangement and different vessel sizes. The report will include an assessment of the need for testing additional configurations and additional vessel scales.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, and scaling testing, plus 8 months
Commitment 5.1.3.10	**Documented test objectives**
Primary Resource	BNI
Deliverable	Requests for technology development will be prepared for each series of related tests amplifying the testing needs documented in 24590-WTP-RPT-ENG-10-001. The report will define information needs and describe how the data is to be used, including review and interpretation of data and testing results. Test objectives include but are not limited to scaling, shearing of waste, vessel bottom phenomena, pump-out, performance testing, heel management, sampling, etc.

	ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.11	**Construction Specifications**
Primary Resource	BNI
Deliverable	Specifications for the 14 foot test platform for integrated system testing will be completed to ensure the testing objectives for the platform can be met. For the 14-ft test vessel this includes prototypic mixing systems, including PJM control, tank-level instrumentation systems, sampling systems, and transfer systems. These systems are fabricated to recognized engineering standards and applicable quality assurance requirements.
Target Completion Date	May 30, 2012
Commitment 5.1.3.12	**Test Specifications**
Primary Resource	BNI
Deliverable	Test specification will be prepared defining test methods, tests, requirements for valid testing, operating ranges, data collection goals and methods, and quality assurance criteria. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.1.3.13	**Scaling Basis**
Primary Resource	BNI
Deliverable	Defining the basis for less-than-full-scale testing, including vessel configurations, operating parameters, and simulant parameters. The basis for scaling both vessel physical performance and simulant physical performance will be addressed. The scaling basis should address

	physical scale laws observed in test results and scale laws used to establish operating conditions for testing. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	April 30, 2012
Commitment 5.1.3.14	**Vessel configurations for testing**
Primary Resource	BNI
Deliverable	Documentation of the basis for selection of specific test configurations for testing relative to assessing and establishing mixing capabilities and process limits across the range of WTP vessels (e.g., mixing power, contents, PJM configuration). The documentation shall define the technical basis and requirements for all test configurations and sizes including the 4-ft, 8-ft, 14-ft, and 6-ft single PJM test platform. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	April 30, 2012
Commitment 5.1.3.15	**Decision point on the need for larger scale testing**
Primary Resource	BNI and DOE
Deliverable	An assessment regarding the need to test vessels larger than 14-ft diameter will be issued. The assessment will include technical criteria for the decision and a full technical justification to support the decision. The determination will include assessment of success, uncertainty, margin, and confidence achieved in prediction of performance in the 14-ft test vessel based on empirical testing and CFD. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, scaling testing, and CFD V&V, plus 8 months.

Commitment 5.1.3.16	**Larger scale testing decision criteria**
Primary Resource	BNI and DOE
Deliverable	An assessment regarding the need to test vessels larger than 14-ft diameter will be issued. The assessment will include technical criteria for the decision and a full technical justification to support the decision. The determination will include assessment of success, uncertainty, margin, and confidence achieved in prediction of performance in the 14-ft test vessel based on empirical testing and CFD. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of reports on stand-alone instrumentation and control tests, integrated 14 foot testing, scaling testing, and CFD V&V, plus 8 months.
Commitment 5.2.3.1	**Physical properties important to mixing and scaling**
Primary Resource	BNI
Deliverable	An assessment of physical properties important to testing and development of mixing scaling relationships will be completed. The report will identify the governing properties and associated ranges that need to be addressed to achieve Newtonian and non-Newtonian test objectives.
Target Completion Date	May 1, 2012
Commitment 5.2.3.2	**Qualification report for selected simulants**
Primary Resource	BNI
Deliverable	Reports will document the basis for the design of simulants for Newtonian and non-Newtonian LSIT. The selected simulant physical and chemical properties (range and variation) and their qualification will be documented. The ERT will review test objective, physical properties important to testing and scaling, proposed requirements for simulants, selected simulants, and simulant qualification and provide comments. ERT review comments and

	resolution will be included with the deliverable transmittal.
Target Completion Date	Delivered with associated test plans, to be issued to DNFSB staff 15 calendar days in advance of conducting tests. (See commitment 5.1.3.6)
Commitment 5.3.3.1	**Update assessment of use of Newtonian analysis techniques to assess non-Newtonian vessel performance**
Primary Resource	BNI
Deliverable	BNI completed an assessment of the use of Newtonian analytical techniques to assess mixing in non-Newtonian vessels (Issued as 24590-WTP-RPT-ENG-11-001, Rev. 0, *Determination that Non-Newtonian Vessels Can Be Evaluated Using Newtonian Techniques*). This report will be updated after completion of testing to further underpin the conclusions in 24590-WTP-RPT-ENG-11-001
Target Completion Date	August 31, 2012
Commitment 5.3.3.2	**Independent review of paper concluding non-Newtonian conditions can be assessed using Newtonian techniques**
Primary Resource	DOE, NETL and ERT
Deliverable	BNI has completed an assessment and concluded mixing in non-Newtonian vessels can be assessed using Newtonian techniques. This assessment is documented in 24590-WTP-RPT-ENG-11-001. An independent review of this assessment will be performed by the NETL and ERT. Conclusions from this review will be documented in an independent review report.
Target Completion Date	December 31, 2012
Commitment 5.3.3.3	**Conclusion regarding use of Newtonian techniques to assess non-Newtonian conditions**
Primary Resource	DOE
Deliverable	Use information from the NETL and ERT review to support a conclusion regarding the viability of using CFD in the analysis of non-

	Newtonian vessel performance for non-Newtonian conditions
Target Completion Date	February 28, 2013
Commitment 5.3.3.4	**Analysis of data sets required to support CFD V&V**
Primary Resource	BNI
Deliverable	Complete an analysis and specify data sets required to support V&V of CFD, including data from 8-ft LSIT testing.
Target Completion Date	February 1, 2012
Commitment 5.3.3.5	**NETL independent review of data sets to support CFD V&V**
Primary Resource	DOE and NETL
Deliverable	Use NETL to conduct an independent review of the BNI gap analysis of data sets planned to be used to complete the CFD V&V
Target Completion Date	May 30, 2012
Commitment 5.3.3.6	**Decision on need for LSIT to support CFD V&V**
Primary Resource	DOE
Deliverable	Use information from the NETL review to support a conclusion regarding the viability of completing CFD V&V prior to obtaining additional LSIT data sets beyond those specified in gap analysis.
Target Completion Date	July 31, 2012
Commitment 5.3.3.7	**Compete V&V of CFD**
Primary Resource	BNI
Deliverable	Complete the V&V of CFD for assessing PJM vessel mixing performance
Target Completion Date	October 31, 2012
Commitment 5.3.3.8	**External review of complete V&V of CFD**
Primary Resource	DOE and NETL

Deliverable	NETL will conduct an external peer review of the completed V&V effort and evaluate whether CFD has the precision required to support design verification of PJM vessel mixing performance
Target Completion Date	Feb 28, 2013
Commitment 5.3.3.9	**Assessment of whether CFD has required precision**
Primary Resource	DOE and BNI
Deliverable	Evaluate whether CFD has the precision required to support design verification of PJM vessel mixing performance
Target Completion Date	August 31, 2013
Commitment 5.3.3.10	**Data required to support assessment of CFD against LSIT**
Primary Resource	BNI
Deliverable	A test specification will be prepared to establish test requirements to obtain required LSIT data to support the CFD PJM benchmarking analysis. The test specification will include the specific criteria that are used to select the large-scale tests to be assessed.
Target Completion Date	October 31, 2012
Commitment 5.3.3.11	**CFD analysis of planned LSIT**
Primary Resource	BNI
Deliverable	A report will be issued ahead of the comparison analyses to document the CFD analysis that will be compared against 8-ft and 14-ft LSIT data and to define acceptance criteria.
Target Completion Date	August 31, 2013
Commitment 5.3.3.12	**CFD prediction of LSIT performance assessment**
Primary Resource	BNI
Deliverable	A report will be prepared documenting results from the comparison of CFD predictions and observed 8-ft and 14-ft LSIT performance

Target Completion Date	Completion of reports on selected comparison tests (5.3.3.10), plus 8 months
Commitment 5.4.3.1	**Identify sampling requirements to support definition of required sampling system testing**
Primary Resource	BNI
Deliverable	Currently planned WTP sampling is identified in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD).* Sampling requirements for plant safety and process control will be developed as part of commitments 5.4.3.2, 5.4.3.3, 5.4.3.4, and 5.4.3.5. BNI will identify the necessary sample points and utilize a DQO process to assess sources of error, required confidence levels, and analysis methods. This information will be used to define what sampling testing is necessary. The standard to assess sample variability will be documented.
Target Completion Date	December 30, 2013
Commitment 5.4.3.2	**WTP sampling requirement input considering tank farm sampling capability**
Primary Resource	BNI
Deliverable	Data quality requirements for waste feed pre-qualification from tank farms will be developed using a process based on the principles of regulatory DQO processes
Target Completion Date	September 30, 2012
Commitment 5.4.3.3	**Develop criticality sampling requirements**
Primary Resource	BNI
Deliverable	Criticality sampling requirements will be developed in an updated version of the preliminary CSER. The updated preliminary CSER will address new information about potential plutonium dioxide particle size and quantity in some Hanford tank waste
Target Completion Date	December 31, 2013

Commitment 5.4.3.4	**WTP process control sampling requirements**
Primary Resource	BNI
Deliverable	WTP sampling requirements for process control will be developed based on the principles of regulatory DQO processes
Target Completion Date	September 30, 2012
Commitment 5.4.3.5	**Sampling required to maintain safety design basis**
Primary Resource	BNI
Deliverable	Hazards analysis of systems will identify sampling needed for maintenance of the safety design basis, particularly in light of new information about waste mixing
Target Completion Date	March 30, 2013
Commitment 5.4.3.6	**Sampling system test plan**
Primary Resource	BNI
Deliverable	A test plan will be prepared for testing to support assessment of sampling system capability. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests
Commitment 5.4.3.7	**Initial sampling system test report**
Primary Resource	BNI
Deliverable	Initial testing results will be issued in a report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of initial sampling system test data report, plus 8 months
Commitment 5.4.3.8	**Integrated testing report**
Primary Resource	BNI
Deliverable	Results from integrated testing will be documented in a report. ERT review comments and resolution will be included with the

	deliverable transmittal.
Target Completion Date	Completion of integrated testing data report, plus 8 months
Commitment 5.4.3.9	**Assessment of sampling system performance and gap analysis**
Primary Resource	BNI
Deliverable	An assessment of sampling system performance against requirements will be completed. The assessment will include the capability to meet requirements for process control and safety. The gap analysis will consider uncertainties in the waste projected to be transferred from the tank farm to WTP and the waste being sampled. The gap analysis will identify the analytical techniques necessary to perform the required sampling analysis. If gaps exist, corrective actions will be taken. Corrective actions may entail design and equipment changes and/or additions or adjustment of sampling requirements. The completed assessment and gap analysis will be documented in a report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of 5.4.3.8 plus 6 months
Commitment 5.5.3.1	**Initial gap analysis between WTP WAC and tank farm sampling and transfer capability**
Primary Resource	WRPS and BNI
Deliverable	Complete an initial gap analysis between Tank Farm sampling system capabilities, uncertainties, and waste projected to be transferred to WTP. This report will include: • Define the initial WAC. • Determine physical characteristics of waste expected to be transferred to WTP with existing feed staging and transfer systems given the uncertainty associated with tank farm characterization data. • Determine capability of staging tank

	sampling system. • Identify analytical techniques necessary to determine the fraction that could exceed the WAC. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	December 31, 2012
Commitment 5.5.3.2	**Evaluation of waste transferred to WTP**
Primary Resource	WRPS
Deliverable	The range of physical properties for waste that is anticipated to be transferred to WTP over the mission will be defined. This assessment will be based on available characterization information including PNNL-20646 EMSP-RPT-006, *Hanford Waste Physical and Rheological Properties: Data and Gaps*, uncertainties (including sampling and analytical error) in the report, and the physical capabilities of the retrieval and transfer systems. Based on available information this assessment will define the preliminary range of physical properties including particle size, particle density, and rheology for waste anticipated to be delivered to WTP with the current feed staging and transfer concepts. The evaluation will include: • Definition of the retrieval and transfer system. • Description of the means and method for determining the standard uncertainties in characterization data that support the physical capabilities of the retrieval and transfer system. • Determination of the performance capabilities of the retrieval and transfer system.
Target Completion Date	June 30, 2012

Commitment 5.5.3.3	**Update the WAC based on LSIT results**
Primary Resource	BNI
Deliverable	• The WAC will be revised based on information developed as part of: • Sub-Recommendation 1 regarding WTP PJM mixed vessel capabilities to prevent accumulation of material that could result in criticality or accumulation of flammable gasses that could result in a deflagration of detonation and accumulation or stratification of solids preventing accurate PMM control that could result in excessive overblows; • Sub-Recommendation 4 regarding the capability of PJM mixed vessels and their sampling systems to meet safety and process control requirements; and • Sub-Recommendation 6 regarding the capability of heel management systems to move waste forward in the process to prevent safety issues.
Target Completion Date	12 months from completion of final LSIT test report.
Commitment 5.5.3.4	**Identification of tank farm sampling and transfer capability test requirements to be documented in a test requirements document**
Primary Resource	WRPS
Deliverable	This work will include identification of test requirements. Testing will cover the range of physical properties of tank waste expected to be staged, sampled, and transferred including uncertainties. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	January 31, 2012
Commitment 5.5.3.5	**Definition of simulants for tank farm performance testing**
Primary Resource	WRPS
Deliverable	Definition and qualification of simulants for testing to establish tank farm performance

	capability ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	March 31, 2012
Commitment 5.5.3.6	**Test plan to establish Tank Farm performance capability**
Primary Resource	WRPS
Deliverable	WRPS will conduct testing 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 characterize waste and determine compliance with the WAC . This work will include development of a test plan. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	May 31, 2012
Commitment 5.5.3.7	**Results from Tank Farm performance testing**
Primary Resource	WRPS
Deliverable	Documentation of test results in a report for tank farm performance testing. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	March 31, 2013
Commitment 5.5.3.8	**Issue remote sampler test report**
Primary Resource	WRPS
Deliverable	The results of the Isolok and Mechanical handling tests will be document in a Final RSD Results Report. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	December 31, 2012
Commitment 5.5.3.9	**Gap Analysis**
Primary Resource	WRPS and BNI

Deliverable	The gap analysis will determine if waste properties for tank waste that can be delivered to WTP exceeds the revised WAC. The gap analysis will assess whether the tank waste staging sampling systems can identify waste that complies and does not comply with the WAC. The gap analysis will determine if engineered features are required to ensure waste delivered to WTP meets the WAC. The analysis will include identification of • The revised WAC • Tank Farm sampling system capabilities and uncertainties. Required analytical techniques to characterize waste. The standard to assess sample variability will be documented. • Description of waste projected to be transferred to WTP given the uncertainty associated with tank farm characterization data. • Gaps between waste that is expected to be transferred and the WTP revised WAC. • Identification of engineering features that may be needed to ensure waste delivered to WTP conforms to the revised WAC. Options for engineered feature to address gaps will include potential scope at both WTP and Tank Farms. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	August 31, 2014
Commitment 5.5.3.10	**Optimized WAC DQO**
Primary Resource	WRPS and BNI
Deliverable	An optimized WTP WAC DQO will be developed to define the final waste acceptance requirements and associated data confidence parameters
Target Completion Date	May 31, 2015
Commitment 5.6.3.1	**Define functional requirements for heel**

	management system
Primary Resource	**BNI**
Deliverable	Functional design criteria and performance capabilities of the heel dilution, heel pump-out, and use of the access ports will be established. WTP has completed an initial evaluation of a heel management system for selected vessels in 24590-WTP-RPT-PET-10-013, *Pretreatment Vessel Heel Dilution/Cleanout Feasibility Study*. The initial functional specifications were provided in 24590-PTF-RPT-ENG-10-004, *Pretreatment Vessel Heel Dilution/Cleanout Functional Requirements*. These requirements will be updated to include specific solids removal objectives relevant to particle size/density and across the range of initial waste rheology conditions that will exist in PJM-mixed vessels.
Target Completion Date	March 31, 2012
Commitment 5.6.3.2	**Heel Management System Design**
Primary Resource	BNI
Deliverable	BNI will incorporate heel management system design changes into FEP, HLP, and UFP designs. The design will include features such as liquid addition to vessels, lowered pump suction, and pumps that can operate with less head.
Target Completion Date	May 30, 2012
Commitment 5.6.3.3	**Heel Management System Description**
Primary Resource	BNI
Deliverable	BNI will update System Descriptions to include the heel management systems functions, description, operations, and maintenance.
Target Completion Date	November 30, 2012
Commitment 5.6.3.4	**Heel Management System hazard analysis**
Primary Resource	BNI
Deliverable	BNI will perform a hazards analysis to integrate nuclear safety requirements into the design of

	the heel management systems. The hazards analysis will be used to finalize the functional requirements for the system and provide required safety criteria.
Target Completion Date	March 30, 2013
Commitment 5.6.3.5	**Heel Management System committed design**
Primary Resource	BNI
Deliverable	BNI will complete the committed design of the heel management systems incorporated into the FEP, HLP, and UFP systems.
Target Completion Date	1 year after completion of Heel Management test report (5.6.3.7)
Commitment 5.6.3.6	**Heel Management test plan**
Primary Resource	BNI
Deliverable	A Test plan will be prepared to obtain performance data on heel management systems and define limits of system capability. Testing will be conducted at three scales as part of the LSIT program to understand performance at progressively larger scales. The testing will be performed under a range of conditions that challenge heel dilution and removal, and will go beyond the design basis conditions to identify the ultimate limits of the system performance. The heel management process involves several operational variables. The testing will evaluate the range of those operational variables by adjusting the weight percent of the solids, adjusting carrier fluid viscosity, chemical additions, adjusting vessel levels, and operating the pulse jet mixers in different sequences. To the extent that normal mixing system operation may result in local solids accumulation (e.g., "batwings"), those conditions will be replicated to determine performance in those circumstances. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Test Plans will be delivered to the DNFSB staff 15 calendar days in advance of conducting tests (see 5.1.3.6)

Commitment 5.6.3.7	**Heel Management test report**
Primary Resource	BNI
Deliverable	Test reports will be issued documenting results from testing of heel management systems. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of test series plus nine months (see 5.1.3.7)
Commitment 5.6.3.8	**Heel Management performance gap analysis**
Primary Resource	BNI
Deliverable	A gap analysis will be completed evaluating heel management system performance against functional design criteria. Design changes will be implemented if performance measured against safety and design margins are not acceptable. ERT review comments and resolution will be included with the deliverable transmittal.
Target Completion Date	Completion of Heel Management test report (5.6.3.7) plus 6 months
Commitment 5.6.3.9	**Assessment of Need for Heel Management in Additional Vessels**
Primary Resource	BNI
Deliverable	Criteria for assessing the need to install heel management systems in WTP PJM mixed vessels will be established. As assessment of the need for heel management systems in Feed Receipt Process, Radioactive Liquid Discharge, and Plant Wash Drain vessel will be completed
Target Completion Date	Completion of Heel Management test report (5.6.3.7) plus 6 months

Commitment 5.7.3.1	**Establish the plan and schedule to systematically evaluate the hazards of known technical issues, M3 vessel assessment summary reports, LOAM benchmark data, and LSIT results.**
Primary Resource:	BNI
Deliverable:	An approved plan that establishes the key activities and schedule to systematically evaluate the hazards and resolve known technical issues and evaluate the results of testing to provide the technical basis to integrate nuclear safety into the Pretreatment Facility design and develop a documented safety analysis that supports commissioning and operations. The plan shall be iterative and develop and validate requirements. The plan shall maintain alignment between design and the safety basis.
Target Completion Date:	January 30, 2012 and updated no less than annually until closure of the IP.
Commitment 5.7.3.2	**Strengthen our Interface Management Program to improve the integrated management of the technical and safety risks in WTP and the tank farms.**
Primary Resource:	DOE
Deliverable:	An updated Interface Management Program Plan that strengthens roles, responsibilities, authorities, and accountabilities for identifying, tracking, managing, and allocating the technical and safety-related risks that span the tank farms/WTP interface and includes a disciplined process to systematically evaluate items to determine their impact on design (i.e., functional and performance requirements) and nuclear safety (i.e., safety bases documents).
Target Completion Date:	July 25, 2012

Commitment 5.7.3.3	**Evaluate the closure document for each sub-recommendation to verify that the results can be implemented in the Hanford tank farms or the WTP.**
Primary Resource:	DOE
Deliverable:	A report will be issued for each sub-recommendation closure documentation review. The report will document the scope of the review, provide objective evidence that the results of the LSIT can be implemented in the Hanford tank farms or WTP, or a plan and schedule to update resolve the technical or safety-related risk and integrate the solution into nuclear safety and the design.
Target Completion Date:	May 9, 2016
Commitment 5.7.3.4	**Identify key inputs, assumptions, safety margin uncertainties, and nuclear safety parameters required to be included in the waste acceptance criteria.**
Primary Resource	BNI
Deliverable:	Report documenting the current nuclear safety parameters that must be included in the WAC. The report will identify the analytical capabilities required to identify waste that exceeds the WAC. If there are changes to the current WAC established in ICD-19, the deliverable will also include the required changes to the ICD.
Target Completion Date:	January 15, 2012
Commitment 5.7.3.5	**Conduct an independent review of the Interface Management Programs strengthened under Commitment 5.7.3.2 to evaluate the effectiveness of the program and implementing procedures and verify that technical and safety-related issues are being identified, evaluated, and tracked to closure.**
Primary Resource	DOE Headquarters
Deliverable:	Independent Assessment Report
Target Completion Date:	January 30, 2013

Commitment 6.3.1	**DOE will provide quarterly progress reports and briefings to the DNFSB and DNFSB staff, including updates on the status of completing actions identified in this IP.**
Primary Resource	DOE-WTP
Deliverable:	Quarterly reports and status briefings on the completion of IP milestones and deliverables. Issues and risks identified, being managed, and closed in the process of conducting work to close DNFSB Recommendation 2010-2 will be reported. The report will identify all commitments delivered in the reporting period.
Target Completion Date:	Quarterly beginning January 2012 until the final milestone is completed.