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

12-WTP-0125

MAR 29 2012

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

TRANSMITTAL OF DEFENSE NUCLEAR FACILITIES SAFETY BOARD (DNFSB) RECOMMENDATION 2010-2 IMPLEMENTATION PLAN (IP) DELIVERABLE 5.1.3.2

Dear Mr. Chairman:

This letter provides you the deliverable required by Commitment 5.1.3.2 of the U.S. Department of Energy (DOE) plan to address Waste Treatment and Immobilization Plant (WTP) Vessels Mixing Issues; IP for DNFSB 2010-2.

DOE with Bechtel National, Inc., has written responses, including plans to address recommendations and issues on Pulse Jet Mixer vessel mixing performance provided by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and the Pacific Northwest National Laboratory (PNNL). Written responses are provided in the attachments.

Meetings are planned to be held starting in April 2012 with CRESP and PNNL to discuss these responses. Outcomes of these discussions will be included in IP Deliverable 5.1.3.3 to document stakeholder acceptance of recommendation dispositions.

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

Sincerely,

Dale E. Knutson

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

WTP:WRW

Attachments (2)

cc: w/attachs: See Page 2

cc w/attachs:
D. M. Busche, BNI
W. W. Gay, BNI
F. M. Russo, BNI
R. G. Skwarek, BNI
C. G. Spencer, BNI
D. McDonald, Ecology
D. G. Huizenga, EM-1
M. B. Moury, EM-1
T. P Mustin, EM-1
K. G. Picha, EM-1
C. S. Trummell, EM-1
A. C. Williams, EM-2.1
M. N. Campagnone, HS-1.1
R. H. Lagdon, Jr., US
BNI Correspondence

ATTACHMENT 1
TO
12-WTP-0125

TRANSMITTAL OF DEFENSE NUCLEAR FACILITIES SAFETY BOARD (DNFSB) RECOMMENDATION 2010-2 IMPLEMENTATION PLAN (IP) DELIVERABLE 5.1.3.2

BNI Letter from R. W. Bradford to D. E. Knutson, "WTP Response to CRESP Review Team Letter Report 7," CCN-232105, dated March 29, 2012.

(No. of Pages: 28)

U.S. Department of Energy
Waste Treatment & Immobilization Plant
Mr. D. E. Knutson
Federal Project Director
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

CCN: 232105

MAR 29 2012

Dear Mr. Knutson:

CONTRACT NO. DE-AC27-01RV14136 – WTP RESPONSE TO CRESP REVIEW TEAM LETTER REPORT 7 - PJM VESSELS

References: 1) Letter, from D. S. Kosson, Ph.D., Review Team Chairman, S. J. Olinger, ORP, *CRESP Review Team Letter Report 7 – PJM Vessels*, dated July 1, 2010.
2) CCN 242510, Letter, from D. E. Knutson, DOE-WTP, to R. W. Bradford, BNI, *Implementation Plan for Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2010-2, Pulse Jet Mixing at the Waste Treatment and Immobilization Plant (WTP)*, 11-WTP-427, dated December 6, 2011.

This letter provides responses to the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) recommendations transmitted to the WTP and documented in Reference 1.

The technical issues identified by CRESP related to the design of mixing, sampling, and transfer systems are planned to be resolved by meeting the commitments documented in *Implementation Plan for DNFSB Recommendation 2010-2* (IP) (Reference 2), including large scale integrated testing. Specific IP commitments associated with CRESP recommendations are identified in the attachment.

WTP will be available to ORP to support meetings in April 2012 with CRESP as desired to discuss the technical basis and/or approach to closure discussed in the attachment. Such meetings may be necessary to support development of the DNFSB 2010-2 IP Deliverable 5.1.3.3, which requires documentation of CRESP's acceptance of recommendation dispositions. This commitment is due August 1, 2012. It is WTP's objective to identify the need for any adjustments to these responses by early May 2012 to facilitate CRESP's acceptance.

For questions, please contact Russell Daniel at (509) 371-3745 or John Olson at (509) 371-3378.

Very truly yours,

R. W. Bradford
Deputy Project Director/Project Manager

JWO/jwo

Attachment: WTP Response to CRESP Review Team Letter Report cc:

Anderson, S. D. w/o	WTP	MS4-A2
Bradford, R. W. w/o	WTP	MS14-3C
Charboneau, S. L. w/o	ORP	H6-60
Crawford, S. S. w/a	WTP	MS14-2B
Daniel, R. B. w/o	WTP	MS4-A2
Dawson, R. L. w/o	DOE-WTP	H6-60
Duncan, G. D. w/o	WTP	MSB1-55
Dunkirk, J. H. w/o	WTP	MS14-3B
French, R. F. w/o	WTP	MS4-B2
Futrell, G. F. w/o	WTP	MS14-2A
Gay, W. W. w/a	WTP	MS4-A2
Gilbert, R. w/o	ORP	H6-60
Hajner, R. S. w/o	WTP	MS14-1B
Hanson, R. L. w/o	WTP	MS4-B2
Harp, B. w/o	ORP	MS14-4A
Julyk, J. L. w/o	WTP	MS4-A2
Kacich, R. M. w/o	WTP	MS14-3B
Keuhlen, P. J. w/a	WTP	MS4-A2
Olsen, J. W. w/o	WTP	MS4-A2
Omel, P. E. w/o	WTP	MS4-A2
Oxenford, W. S. w/o	WTP	MS4-A2
Reddick, J. w/o	ORP	H6-60
Russo, F. M. w/o	WTP	MS14-3C
Samuelson, S. L. w/o	ORP	H6-60
Sawyer, S. L. w/o	WTP	MS14-3C
Scarpino, J. A. w/o	WTP	MS14-3B
Underhill, W. L. w/o	WTP	MS4-A2
Voke, R. w/o	WTP	MS5-G
DOE Correspondence Control w/a	ORP	H6-60
PADC w/a	WTP	MS19-A

Recommendation 1 *Near full scale vessel testing (1/8 scale or larger on a volumetric basis) facilities and simulation capabilities should be available for design confirmation and during the full life cycle of WTP operations.*

Status:

Accepted, open. Large scale integrated testing is currently planned in 4 ft, 8 ft, and 14 ft test vessels. A new 14 ft vessel test facility is currently being constructed. The 14 ft test vessel meets the CRESP recommended "1/8 scale or larger on a volumetric basis" for all but the largest vessels. A new 14 ft vessel test facility is currently being constructed.

Background:

WTP Contract Modifications 199 and 221, *Change Order for Large Scale Testing*, were issued to include execution of Large Scale Testing (LSIT) in the Scope of Work for WTP. The scope of work includes the construction of a 14 ft test vessel facility to demonstrate performance of both Newtonian and non-Newtonian vessel geometry. Per the contract modification, the required testing includes:

1) Substantiation of the committed design;
2) Engineering, procurement, and construction risk reduction;
3) Design confirmation including benchmarking or validating Computational Fluid Dynamic models and low order models
4) Waste Treatment and Immobilization Plant commissioning risk reduction

One detailed objective included in Contract Modification No. 221 is confirmation of scaling parameters for both non-Newtonian and Newtonian vessels, where applicable.

Actions to Resolve:

1. (COMPLETE) Document principal safety issues with residual uncertainty that are to be investigated in large scale testing.
   - *Implementation Plan for DNFSB Recommendation 2010-2* (IP) (CCN 242510) lists safety issues relevant to pulse jet mixing and transfer systems. The IP provides for documentation and management of residual risks (uncertainty) in 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).
2. (COMPLETE) Document the key activities to systematically identify and evaluate hazards of known technical issues.
   - *Plan and Schedule to Systematically Evaluate the Hazards of Known Technical Issues, M3 Vessel Assessment Summary Reports, LOAM Benchmark Data and LSIT – Response to DNFSB Recommendation 2010-02 Implementation Plan Commitment 5.7.3.1* (24590-PTF-PL-ENS-11-0007, Rev. 0) lists known technical issues in Attachment A and provides a plan and schedule to address known technical issues. Of the 99 known technical issues, 3 have been closed as of March 19, 2012.

3. (COMPLETE) Define initial construction requirements and specifications for the near full scale test platform. The scale of the large vessel (14 ft diameter) is based on recommendations from CRESP and the External Review Team (ERT).
   - The Large Scale Test Platform is a 14 ft diameter test vessel facility and is detailed in *Engineering Specification for Large Scale Integrated Testing 14ft Platform Specification* (24590-WTP-3PS-G00Y-T0002, Rev. 0).
4. (IN PROGRESS) Update the overall strategy and bases for near full scale testing. The *Integrated Pulse Jet Mixed Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1) documents the plans and bases for near full scale testing. Large Scale Testing activities will support design verification and include prototypic testing to demonstrate certain vessel design features.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updated information from the IP] (IP Commitment 5.1.3.1, Target Completion Date August 1, 2012).
5. (IN PROGRESS) Develop details on the size and configuration of test platforms. Current plans include testing on 3 different platforms: 4 ft diameter, 8 ft diameter, and 14 ft diameter. Newtonian (distributed array) and non-Newtonian (clustered array) vessels will be tested that are essentially full-scale (for some vessels) at 14 ft and achieves the recommendation for "near full scale" testing for all but the largest WTP vessels.
   - Vessel configurations for testing (IP Commitment 5.1.3.14; Target Completion Date April 30, 2012).
6. (IN PROGRESS) Design primary equipment in the large scale testing with capability for long term use. *Engineering Specification for Large Scale Integrated Testing 14ft Platform Specification* (24590-WTP-3PS-G00Y-T0002, Rev. 0) states, "It is the intent that this system shall be robust in design to function throughout the duration of LSIT. From [Contract] Mod 221, key equipment such as test vessels used in this work shall be designed such that reuse in potential future post commissioning testing to support continued WTP operations is not precluded." In summary, primary equipment for LSIT is to be designed to allow long term utilization, as required by the WTP Contract.
   - Construction specifications [updated with information from the IP] (IP Commitment 5.1.3.11; Target Completion Date May 30, 2012).
7. (IN PROGRESS) Develop simulation capabilities to be used for design confirmation and possible long term use. *The V&V Plan for Computational Fluid Dynamics Modeling of the PJM Vessels for the Hanford Tank Waste Treatment and Immobilization Plant Project* (24590-WTP-PL-ENG-11-002, Rev. B) describes the methodology being followed to qualify a computational fluid dynamics (CFD) simulation model for assessment of WTP full-scale pulse jet mixed (PJM) vessel performance.
   - Complete V&V of CFD (IP Commitment 5.3.3.7; Target Completion Date October 31, 2012).

8. (ONGOING) Include national laboratory support in the development of the large scale integrated test program. Pacific Northwest National Laboratory (PNNL) and Savannah River National Laboratory (SRNL) have been engaged with responsibility for key basis documents related to simulant bases, scaling, and test planning.
   - PNNL subcontract under 24590-QL-HC9-WA49-00001, Service Requisition *Technical Support for Large Scale Integrated Testing (LSIT)* (24590-QL-SRA-W000-00160).
   - SRNL subcontract under SCT-M0SRV00028-00, Service Requisition *Initiate SRNL Support of the Large Scale Integrated Test Program* (SCT-M0SRV00028-00-011).
9. (ONGOING) Include consultation and reviews from a panel of mixing experts with varied backgrounds in the development and execution of testing and interpretation of test results. An Expert Review Team (ERT), comprised of members from national laboratories, industry, and academia, is engaged to advise on near full scale testing. The scope of the ERT is documented in *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 2 *PJM vessel designs should retain as much flexibility as possible to process the expected range of feed compositions and to mitigate off-design and upset conditions.*

Status:

Accepted, open. Design and safety margin testing is included in plans for LSIT. Also, new features in the design for select vessels (heel management and access port capabilities) offer increased flexibility.

Background:

During final testing and analysis activities as part of closure of the M3 technical issue, modifications to the plant were incorporated into the closure documents to reduce WTP operational risk. The WTP implemented modifications to eight of the Pretreatment (PT) vessels that contain solids to add heel removal capability. Two PT vessels previously had this capability. Two equipment access ports were added in each of 10 PT vessels that contain solids, and a dedicated Tank Farm to low-activity waste (LAW) feed receipt header was added in PTF to FRP-VSL-00002A/B/C/D. These vessel modifications are considered operational risk reduction or mitigation features but are not credited to meet performance and safety requirements. The vessel modifications identified in the *M3 Technology Steering Group Closure Records* (CCN 220452 through 220455) ensure the designs meet the mixing requirements and include increasing the PJM drive velocity in seven PT vessels that contain solids, increasing the number of PJMs in three PT vessels that contain solids, and adjusting the maximum solids concentration in the feed to three PT vessels.

Actions to Resolve:

1. (COMPLETE) Provide capability for PJM control and operation flexibility in the design. PJMs are capable of being operated independently allowing for flexibility in PJM modes of operation and non-synchronous PJM operations (e.g., firing just 2 PJMs during heel removal as described in the heel management conceptual design).
   - The control scheme is demonstrated in the typical arrangements for PJM control racks shown on *P&ID Symbols and Legend Sheet 7 of 8* (24590-WTP-M6-50-00007, Rev. 3).
2. (COMPLETE) Provide means to condition waste for waste processing flexibility at key points throughout the facility. Operational flexibility exists throughout the plant including capability to adjust the washing, solids concentrating, and chemical concentrating steps. Beyond reagent additions required for the design basis waste processing, each vessel has a wash ring through which chemicals can be added to the vessel as a means to rinse the vessel or to condition the waste.
   - *Plant Wash Philosophy* (24590-WTP-RPT-PR-02-001, Rev. 0).
3. (COMPLETE) Develop a method to determine the appropriate waste processing strategy for each waste feed planned for transfer from the tank farms to WTP. The waste pre-qualification strategy is used to assess chemical, physical, and rheological properties of the actual feed stream prior to processing through the WTP. Waste samples are subjected to a series of laboratory-scale tests to determine how the material will behave as it moves through WTP unit operations.
   - *Plan for WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).
4. (IN PROGRESS) Provide additional means of waste processing flexibility with regard to off-design and upset conditions. The conceptual design for a heel management system which includes physical attributes and capabilities for access ports are described in 24590-PTF-RPT-ENG-10-004, Rev. 0 - *Pretreatment Vessel Heel Dilution/Cleanout Functional Requirements*. Functional requirements and performance capabilities of the heel management system including off-normal heel management design requirements are under development.
   - Define functional design criteria for heel management system (IP Commitment 5.6.3.1; Target Completion Date March 31, 2012).
   - Heel Management System Description (IP Commitment 5.6.3.3; Target Completion Date November 30, 2012).
   - Heel Management test report (IP Commitment 5.6.3.7; Target Completion Date completion of test series plus nine months).
   - Heel Management System committed design (IP Commitment 5.6.3.5; Target Completion Date one year after completion of Heel Management test report).

5. (IN PROGRESS) Assess the need for further design capability to process waste beyond the current design basis. As documented in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510), a gap analysis will assess the need for further design capability based on the initial Waste Acceptance Criteria (WAC) for WTP, Tank Farm sampling system capabilities, and projected WTP feed characteristics.
   - Initial gap analysis between WTP WAC and tank farm sampling and transfer capability (IP Commitment 5.5.3.1; Target Completion Date December 31, 2012).
   - Evaluation of waste transferred to WTP (IP Commitment 5.5.3.2; Target Completion Date June 30, 2012).
   - Update the WAC based on LSIT results (IP Commitment 5.5.3.3; Target Completion Date 12 months after completion of final LSIT test report).
   - The need for engineered features (potentially for either the WTP or Tank Farms) to ensure waste delivered to WTP conforms to the revised WAC will be determined in a Gap Analysis (IP Commitment 5.5.3.9, Target Completion Date August 31, 2014)
6. (IN PROGRESS) Develop simulants for LSIT that cover the range of expected tank waste physical properties. As required by Contract Modification No. 221, an objective of the Large Scale Integrated Testing is confirmation of mixing performance with complex simulants including Newtonian and non-Newtonian properties that span the range of expected tank waste physical properties.
   - Physical properties important to mixing and scaling (IP Commitment 5.2.3.1; Target Completion Date May 1, 2012).
   - Qualification reports for simulants (IP Commitment 5.2.3.2; Target Completion Date 15 days in advance of conducting tests).
7. (ONGOING) Include consultation and reviews from a panel of mixing experts in the development of simulants. The simulant design basis will be documented in a simulant report and reviewed by the ERT.
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

Issue Closure:

Following completion of the listed actions: the Heel Management System committed design; performance testing results; and gap analysis between WTP WAC and tank farm sampling and transfer capability will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 3 *The cumulative design margin as a result of design assumptions should be quantitatively assessed against the individual batches of the planned feed vector (e.g., with respect to zone of influence (ZOI), mixing energy/power, actual anticipated settling velocities).*

Status:

Accepted, open. Design and safety margin testing is included in the plans for LSIT. Also, the WTP feed prequalification process will establish a run plan for each batch of waste feed planned for transfer.

Background:

One detailed objective included in Contract Modification No. 221 is determination and demonstration of mixing system limiting conditions of design including safety limits and operating limits. *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1) documents that design and safety margin testing is included in the plans for LSIT.

Actions to Resolve:

1. (COMPLETE) Estimate margin in the design based on knowledge and tools currently available. Preliminary performance margin has been evaluated as part of the individual vessel assessments.
   - *EFRT Issue M3 PJM Vessel Mixing Assessments* (24590-WTP-RPT-ENG-08-021-01 through 10).
2. (COMPLETE) Develop a plan to ensure batches of waste transferred to WTP are systematically evaluated for efficient processing within limits of WTP unit operations. The Waste Pre-qualification Process establishes a waste feed run plan, including possible physical, chemical, or rheology adjustments, where process parameters are optimized to balance throughput.
   - *Plan for WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).
3. (IN PROGRESS) Determine margin in the design using LSIT results or analytical methods to establish operating limits. As documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1), design and safety margin testing is included in the plans for LSIT.
   - Develop test plan (IP Commitment 5.1.3.6; Target Completion Date 15 days in advance of conducting tests).
4. (IN PROGRESS) Develop a plan to ensure waste transferred to the WTP meets the WAC. As documented in the *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510), a gap analysis will be performed to assess the expected range of waste properties for waste transferred to WTP and the staging tank sampling system's capabilities. The gap analysis will also determine if there is a need for additional engineered features or changes to the current WAC.
   - Initial gap analysis between WTP WAC and tank farm sampling and transfer capability (IP Commitment 5.5.3.1; Target Completion Date December 31, 2012).
   - Evaluation of waste transferred to WTP (IP Commitment 5.5.3.2; Target Completion Date June 30, 2012).
   - Update the WAC based on LSIT Results (IP Commitment 5.5.3.3; Target Completion Date 12 months from completion of final LSIT test report).
5. (ONGOING) Include consultation and reviews from a panel of mixing experts in the planning of margin testing and interpretation of results from margin testing. The scope of the ERT includes technical review of test objectives, test design, and interpretation of test results.
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; performance testing results; and gap analysis between WTP WAC and tank farm sampling and transfer capability will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 4 *A tracking system should be instituted for design assumptions that impose requirements on the feed qualification program.*

Status:

Accepted, open. Requirements for waste acceptance are documented, but a means of documenting the specific assumptions referred to in this recommendation needs to be developed.

Background:

Requirements for the waste acceptance program are documented in *ICD 19 - Interface Control Document for Waste Feed* (24590-WTP-ICD-MG-01-019, Rev. 5). ICD19 presents interface responsibilities and actions for the Waste Treatment Plant, the Tank Operations Contractor (TOC), and the US Department of Energy. ICD19 defines the design requirements and limitations that must be met by the WTP and the TOC in order to successfully transfer and receive waste that is within processing capabilities at both WTP and the tank farms. ICD19 is maintained as a design basis document in accordance with WTP procedures. Actions listed below include descriptions of existing and planned methods for tracking design assumptions.

Actions to Resolve:

1. (COMPLETE) Develop a method for tracking all engineering calculation assumptions that are not immediately technically justified and requiring verification.
    - WTP CalcTrac is used to track all unverified assumptions used in BNI engineering calculations.
2. (COMPLETE) Develop a method for tracking all design inputs used in safety calculations.
    - The Safety Analysis Inputs Database (SAID) is used by E&NS to track all design inputs (whether preliminary, committed, or confirmed) used in safety calculations and generate reports to search for changes to referenced documents.
3. (COMPLETE) Track WTP safety hazard information to support process hazard analyses.
    - E&NS maintains databases to compile written process safety information appropriate to the stage of design considered in hazard analyses.

4. (COMPLETE) An initial particle size distribution design basis for Newtonian and non-Newtonian waste has been developed. Current basis of particle size distribution can be found in the documents shown below.
   - Requirements for the waste acceptance program are documented in *ICD 19 - Interface Control Document for Waste Feed* (24590-WTP-ICD-MG-01-019, Rev. 5).
   - Current design basis criteria are documented in *Basis of Design* (24590-WTP-DB-ENG-01-001, Rev. 1Q).
   - Safety requirements are documented in *Preliminary Documented Safety Analysis to Support Construction Authorization; PT Facility Specific Information* (24590-WTP-PSAR-ESH-01-002-02, Rev. 4W).
5. (COMPLETE) The range of physical properties for waste that is anticipated to be transferred to WTP over the mission will be defined. 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.
   - Evaluation of waste transferred to WTP (IP Commitment 5.5.3.2; Target Completion Date June 30, 2012).
6. (COMPLETE) The process of confirming calculations (e.g., pulse jet mixed vessel designs) by closing unverified assumptions in CalcTrac has been established. Per the WTP procedure, all unverified assumptions must be closed for confirmation of design calculations.
   - *Engineering Calculations* (24590-WTP-3DP-G04B-00037, Rev. 19A).
7. (IN PROGRESS) In addition to maintaining existing systems, develop a database to track other assumptions about waste feed that may impact the waste feed qualification program.
   - The action to create a tracking system for WTP mixing system design assumptions is captured in 24590-WTP-ATS-MGT-11-0608.
8. (IN PROGRESS) Develop a final data quality process to be used for WTP sample qualification. The DQO process, to be developed through iterations of the *Initial Data Quality Objectives for WTP Feed Acceptance Criteria* (24590-WTP-RPT-MGT-11-014, Rev. 0) will identify the necessary sample points, required confidence levels, and analysis methods.
   - WTP process control sampling requirements (IP Commitment 5.4.3.4; Target Completion Date September 30, 2012).

Issue Closure:

Following completion of the listed actions: development of a tracking system for assumptions that may impact the waste feed qualification program, documented WTP process control sampling requirements, and documented physical properties important to mixing and scaling will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 5 *Functional performance specifications need to be developed for inspecting and accessing vessel bottoms.*

Status:

Accepted, open. A conceptual design has been developed for access ports to be added to 10 pretreatment vessels containing solids. The development of the access ports design follows the WTP design process, and as operational experience is gained, the uses for the access ports will continue to be matured.

Background:

The EFRT issue M3 closure documentation includes recommended vessel modifications to eight Pretreatment vessels containing solids to add heel removal capability (two already had this capability) and to add two equipment access ports to 10 Pretreatment vessels containing solids. A conceptual design for the access ports has been issued. Functional requirements for access ports are under development.

Actions to Resolve:

1. (COMPLETE) Provide a conceptual design for vessel access ports.
   - The conceptual design for a heel management system which includes physical attributes and capabilities for access ports are described in *Pretreatment Vessel Heel Dilution/Cleanout Functional Requirements* (24590-PTF-RPT-ENG-10-004, Rev. 0).
2. (COMPLETE) Perform a preliminary safety assessment of the conceptual design.
   - *ISM III PTF – M3 Vessel Access Ports* (CCN 223268) documents the results of a review to identify potential hazards, initiators, consequences, and controls for the installation of access ports and access port entry based on the conceptual design.
3. (IN PROGRESS) Document functional requirements for access ports which may be used to inspect and access vessel bottoms. Functional requirements and performance capabilities of the heel management system (including access ports) are under development and will be documented in a Heel Management Design Requirements document. Requirements will also be documented for off-normal heel management operations.
   - Define functional design criteria for heel management system (IP Commitment 5.6.3.1; Target Completion Date March 31, 2012).
4. (IN PROGRESS) Conduct large scale tests to assess the performance of the heel management system to its design basis and beyond. Per contract modification 221, WTP is required to demonstrate the heel removal system capability. Heel management design testing is included in the plans for LSIT.
   - Heel Management test plan (IP Commitment 5.6.3.6; Target Completion Date 15 calendar days in advance of conducting tests).
   - Heel Management test report (IP Commitment 5.6.3.7; Target Completion Date completion of test series plus nine months).

Issue Closure:

Following completion of the listed actions: the heel management design requirements document; and heel management testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 6 ***Sensitivity analysis should be carried out for WTP throughput as a function of heel removal needs and operating strategies.***

Status:

Accepted, open. WTP throughput will be analyzed using the G2 model of the WTP flowsheet with the final heel management design incorporated.

Background:

The 2010 Tank Utilization Assessment (TUA) included the conceptual heel management system design in an analysis of WTP throughput. The G2 model indicated that when the conceptual heel removal systems are implemented there is minimal impact on the time required to treat all waste feeds.

Actions to Resolve:

1. (COMPLETE) Determine the conceptual heel management system design impact on plant throughput. WTP mission life had minimal impact according to the G2 Model with the conceptual heel management system incorporated.
   - Sensitivity to the initial heel removal design concept is documented in *Pretreatment Vessel Heel Dilution/Cleanout Feasibility Study* (24590-WTP-RPT-PET-10-013, Rev. 0).
2. (IN PROGRESS) Establish the heel management design basis. Functional requirements and performance capabilities of the heel management system are under development and will be documented in a Heel Management Design Requirements document.
   - Define functional design criteria for heel management system (IP Commitment 5.6.3.1; Target Completion Date March 31, 2012).
3. (IN PROGRESS) Model the planned heel removal frequencies and operating strategies in G2. The *2010 WTP Tank Utilization Assessment (TUA)* (24590-WTP-RPT-PET-10-020, Rev. 0) concluded periodic dilution and removal of heels from vessels requiring heel management had no identifiable impact on the time required to treat all planned WTP feeds. An updated TUA will be issued, as needed, with the development of the heel management design.
   - Heel Management System committed design (IP Commitment 5.6.3.5; Target Completion Date one year after completion of Heel Management test report).
4. (IN PROGRESS) Demonstrate the WTP heel removal design capability. In accordance with *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1), the heel removal system will be tested in the LSIT to gather data on performance and demonstrate that the removal capability in a prototypic vessel is consistent with the current design requirement of no solids accumulation.
   - Heel Management test plan (IP Commitment 5.6.3.6; Target Completion Date 15 calendar days in advance of conducting tests).
   - Heel Management test report (IP Commitment 5.6.3.7; Target Completion Date Completion of test series plus nine months).

Issue Closure:

Following completion of the listed actions: the heel management design requirements document; and heel management testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 7 *Systems level assessments of tank waste processing should consider alternative processing strategies for the most challenging tank wastes as part of the defense in depth strategy.*

Status:

Accepted, open. Work in progress to evaluate alternative waste processing strategies includes large scale testing and a Non-Newtonian vessel trade study, which will evaluate potential alternative design and operating strategy.

Background:

In terms of processing waste that falls within the baseline, tank waste characterization contains many facets and includes both chemical and physical properties of waste. Over the years the WTP has considered many possible scenarios for tank waste processing but more importantly the WTP has established a baseline process scheme along with the underlying assumptions to provide the DOE with assurance that the chemical processes are capable of supporting the throughput requirements of the contracted statement of work (Section C of DE-AC27-01RV14136). Studies have been conducted to investigate the possibility of constructing additional processing features or capabilities outside of WTP. These include construction of waste feed conditioning facilities to perform leaching outside of the WTP, particle size reduction, and added waste concentration capability prior to high-level waste (HLW) vitrification.

Actions to Resolve:

1. (COMPLETE) Develop a method to determine the appropriate waste processing strategy for each waste feed planned for transfer from the tank farms to WTP. The waste pre-qualification strategy is used to assess chemical, physical, and rheological properties of the actual feed stream prior to processing through the WTP. Waste samples are subjected to a series of laboratory-scale tests to determine how the material will behave as it moves through WTP unit operations.
    - *Plan for WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).

2. (IN PROGRESS) Gain WTP operational experience prior to processing the most challenging tank wastes. DOE recently directed BNI to implement capability for direct feed delivery to support LAW and commission LAW in advance of higher hazard facilities. This allows for experience from successful completion of the LAW Operational Readiness Review (ORR) to be used in preparation for hot commissioning activities in the HLW and PT facilities. This direction also includes a phased waste feed delivery strategy to account for evolution of the Waste Acceptance Criteria (WAC). This strategy maximizes the operating experience gained up front in the life of the plant.
   - *Direction to Re-Baseline/Re-Plan the Waste Treatment and Immobilization Plant (WTP) and Request for Contract Change Proposal and Associated Baseline Change Proposal* (CCN 244830).
3. (IN PROGRESS) Determine capability for processing the most challenging tank wastes through testing. Large scale integrated testing is being pursued to inform the Project of the capabilities and margin of the current design and mixing controls.
   - Analysis of test results (IP Commitment 5.1.3.7; Target Completion Date Completion of test series plus nine months).
4. (IN PROGRESS) Demonstrate that a sufficient fraction of the Hanford tank waste inventory can be processed at WTP. LSIT will develop simulants to determine performance limits for waste mixing and transfer systems. The simulants will represent the full range of known tank waste properties and will be documented in a simulant report. Results of performance testing will be incorporated in the basis for WAC.
   - Physical properties important to mixing and scaling (IP Commitment 5.2.3.1; Target Completion Date May 1, 2012).
   - Qualification report for selected simulants (IP Commitment 5.2.3.2; Target Completion Date 15 days prior to conducting tests).
5. (IN PROGRESS) Conduct a study of alternatives to the current pulse jet mixing design in parallel with LSIT. An initial study has been completed which identified potential design or operating strategies as contingency to the current non-Newtonian Vessel design.
   - A request to proceed with further analysis of alternatives was documented in *Non-Newtonian Vessel Trade-off Study Request to Proceed, Initial Study Results* (CCN 232104).
6. (IN PROGRESS) Assess WTP process unit operations and systems through performance testing. Testing required by the WTP contract includes waste separations processing (removal of entrained solids), sludge-washing, oxidative leaching, and vessel mixing. Vessel mixing tests will be addressed by LSIT.
   - Test Specifications (IP Commitment 5.1.3.12; Target Completion Date 15 calendar days in advance of conducting tests).
7. (IN PROGRESS) Document Data Quality Objectives (DQO) for WTP Feed Acceptance Criteria. The initial DQO establishes the process for developing the final WAC DQOs.
   - Initial DQOs of the waste acceptance criteria have been developed and documented in *Initial Data Quality Objectives for WTP Feed Acceptance Criteria* (24590-WTP-RPT-MGT-11-014, Rev. 0).

8. (IN PROGRESS) Utilize a DQO process in conjunction with an uncertainty methodology to assess sources of error, required confidence levels, and analysis methods for planned WTP sampling. Currently planned WTP sampling is identified in *Integrated Sampling and Analysis Requirements Document (ISARD).*
   - WTP sampling requirement input considering tank farm sampling capability (IP Commitment 5.4.3.2; Target Completion Date September 30, 2012).
   - WTP process control sampling requirements (IP Commitment 5.4.3.4; Target Completion Date September 30, 2012).
   - Sampling required to maintain safety design basis (IP Commitment 5.4.3.5; Target Completion Date March 30, 2013).
   - Develop criticality sampling requirements (IP Commitment 5.4.3.3; Target Completion Date December 31, 2013).
9. (IN PROGRESS) Assess the need for further design capability to process waste beyond the current design basis. As documented in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510), a gap analysis will assess the need for further design capability based on the initial Waste Acceptance Criteria (WAC) for WTP, Tank Farm sampling system capabilities, and projected WTP feed characteristics.
   - Initial gap analysis between WTP WAC and tank farm sampling and transfer capability (IP Commitment 5.5.3.1; Target Completion Date December 31, 2012).
   - Evaluation of waste transferred to WTP (IP Commitment 5.5.3.2; Target Completion Date June 30, 2012).
   - Update the WAC based on LSIT results (IP Commitment 5.5.3.3; Target Completion Date 12 months after completion of final LSIT test report).
   - The need for engineered features (potentially for either the WTP or Tank Farms) to ensure waste delivered to WTP conforms to the revised WAC will be determined in the Gap Analysis (IP Commitment 5.5.3.9, Target Completion Date August 31, 2014)
10. (ONGOING) Document the review of *Implementation Plan for DNFSB Recommendation 2010-2* (IP) (CCN 242510) sub-recommendation closures.
    - Evaluate the closure document for each sub-recommendation to verify that the results can be implemented in the Hanford tank farms or the WTP (IP Commitment 5.7.3.3; Target Completion Date May 9, 2016).

Issue Closure:
Following completion of the listed actions: the simulant qualification report; performance testing results; and gap analysis between WTP WAC and tank farm sampling and transfer capability will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 8 *Integrated vessel performance under design basis event (DBE) conditions should be verified using actual vessels or a near full scale cold test platform. Individual PJM ZOI scale up and restart after a DBE should be verified at or near full scale for a range of simulants that reflect the range of properties expected to be encountered during waste processing.*

Status:

Accepted, open. Current plans for LSIT include testing to determine the limits and margin of the pulse jet mixing system design and restart after a DBE.

Background:

In the M3 program, it was concluded that a settled layer of Newtonian slurry solids could develop up to 200 Pa shear strength in 24 hours. Testing in the M3 program (on a 4 ft test vessel platform) demonstrated the simulant would be remobilized from that condition. Also, non-Newtonian Pulse Jet Mixer Testing performed by PNNL demonstrated the ability to reestablish full mixing and release accumulated gas from a 600 Pa shear strength condition. This study is documented in *Overview of the Pulse Jet Mixer Non-Newtonian Scaled Test Program* (24590-101-TSA-W000-0004-114-00019, Rev. B). One detailed objective included in Contract Modification 221 is determination and demonstration of mixing system limiting conditions of design including safety limits and operating limits.

Actions to Resolve:

1. (COMPLETE) Identify the mixing structures, systems, and components (SSC) required to perform a safety function post-DBE. The *Preliminary Documented Safety Analysis* (PDSA) and PDSA addendum describe the safety class SSC at the functional level specifically identified in the DBE analysis. A specific administrative control (SAC) is identified in the *Preliminary Documented Safety Analysis* (PDSA) to accomplish agitation of the waste within the calculated time to lower flammability limit thereby preventing a hydrogen hazard.
   - *Preliminary Documented Safety Analysis to Support Construction Authorization; PT Facility Specific Information*, 24590-WTP-PSAR-ESH-01-002-02, Rev. 4v, Section 4.3 (PDSA).
   - *Preliminary Documented Safety Analysis - Control Strategy Changes for the PT Facility* (24590-WTP-PSARA-ENS-09-0001, Rev. 5).
2. (IN PROGRESS) Complete the strategy for the prevention of hydrogen accumulation in pulse jet mixed vessels. The final strategy for this SAC has not been developed and will require an integrated effort from Engineering, Operations, and Environmental & Nuclear Safety.
   - Safety Basis Approval Strategy Document (IP Commitment 5.0.1; Target Completion Date June 30, 2012).
3. (IN PROGRESS) Include testing to determine the limits and margin of the pulse jet mixing system design in plans for large scale testing. LSIT objectives include determination of the limits of operability against the range of potential waste feed characteristics.
   - Test specifications (IP Commitment 5.1.3.12; Target Completion Date 15 calendar days in advance of conducting tests).

4. (IN PROGRESS) Demonstrate that settled Newtonian waste can be remobilized from a settled state following an upset condition or design basis event. LSIT includes testing to show settled solids with significant shear strength can be remobilized to prevent trapping of hydrogen (flammable gases in the solids layer). Remobilization testing includes determination of margin (e.g., higher shear strength, minimum number of PJMs required to remobilize waste) as documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1)
   - Analysis of test results (IP Commitment 5.1.3.7; Target Completion Date Completion of test series plus nine months).
5. (IN PROGRESS) Include integrated mixing, sampling, and transfer system testing in plans for large scale testing. Testing will include both normal and off-normal operations. A Newtonian (distributed array) and non-Newtonian (clustered array) vessel and PJM configuration will be tested with integrated vessel features and capabilities.
   - Integrated testing report (IP Commitment 5.4.3.8; Target Completion Date eight months after completion of integrated testing data report).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 9 *Assessments of potential particle segregation during sedimentation should consider estimates based on considerations beyond the equivalent volume sphere.*

Status:

Accepted, open. LSIT simulant development will consider process slurry fluid characteristics and the important characteristics of simulant particles.

Background:

Based on the CRESP recommendation, additional reviews of literature have been undertaken to review the importance of shape to particle settling and suspension. They indicate that smooth spherical shapes settle faster than less smooth and less round shapes and are also harder to suspend. In the M3 program, the equivalent volume sphere was intended for study of particle settling and was not used in studies of particle coherence or line plugging.

Actions to Resolve:

1. (COMPLETE) Document the basis for the component selected to represent waste PuO_2 particles in the simulant.
   - The PuO_2 equivalent volume sphere is determined in *Evaluation of Plutonium Settling in Pretreatment Vessels* (CCN 211814, February 2010).
   - *HLW Sludge Simulant Qualification Data Package* (CCN 214953, March 2010) shows that the PuO_2 surrogate used in simulants for previous pulse jet mixing tests exceeds the equivalent volume sphere of a 40 μm PuO_2 particle.

2. (COMPLETE) Review various literature with regard to nonspherical particle settling. The following bullets are from references used for guidance in re-evaluation of the effect of shape on particle settling analyses.
   - Chapter 8 of the *Handbook of Water and Wastewater Treatment Technologies*[1] states, "In designing a system based on the settling velocity of nonspherical particles, the linear size in the Reynolds number definition is taken to be the equivalent diameter of a sphere, d, which is equal to a sphere diameter having the same volume as the particle (p. 275)."
   - Chhabra[2] finds the orientation for non-spherical particles must be specified before the drag force can be calculated. (p. 274). This is in agreement with *Perry's Chemical Engineers' Handbook*[3], which states, "drag on a nonspherical particle depends upon its shape and orientation with respect to the direction of motion."
   - Figure 6-57 from *Perry's Chemical Engineers' Handbook*[3] shows at Reynold's numbers greater than 100, spherical particles have a lower drag coefficient than disks or cylinders.
   - In general, *Slurry Transport Using Centrifugal Pumps*[4] finds that during sedimentation, particles will orient themselves so as to maximize drag (p. 45). In other words, a lens-shaped particle will settle with maximum surface area horizontal.
3. (IN PROGRESS) Include relevant mixing performance and the full range of tank waste characteristics in the LSIT simulant selection criteria. Physical mixing testing simulants will be a combination of irregular mineral components with limited amounts (spikes) of engineered (typically spherical or rounded) particles added in specific size and density bins. This is reasonable in that the waste particles are irregular and in the cases where an engineered spike is added it will have conservative settling and suspension characteristics.
   - Qualification reports for simulants (IP Commitment 5.2.3.2; Target Completion Date 15 calendar days in advance of conducting tests).
4. (IN PROGRESS) Develop simulants for use in LSIT that represent expected characteristics of non-Newtonian waste transfers to WTP. Constituents will be selected to mimic key parameters important to vessel mixing, including slurry bulk density, slurry rheology, particle size and density distribution. The large scale testing will test with non-Newtonian slurries (most likely clay mixtures) in which larger and denser particle spikes have been embedded.
   - Physical properties important to mixing and scaling (IP Commitment 5.2.3.1; Target Completion Date May 1, 2012).

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[1] N. P. Cheremisinoff, Handbook of Water and Wastewater Treatment Technologies, Butterworth-Heinemann (2002).

[2] R. P. Chhabra, J. F. Richardson, Non-Newtonian Flow and Applied Rheology, 2nd Edition, Elsevier (2008).

[3] R. H. Perry, D. W. Green, Perry's Chemical Engineers' Handbook, 8th Edition, McGraw-Hill (2008).

[4] K. C. Wilson, G. R. Addie, A. Sellgren, and R. Clift, Slurry Transport Using Centrifugal Pumps, 3rd Edition, Springer (2006).

5. (IN PROGRESS) Expand knowledge of waste feed characterization to ensure the LSIT simulant basis spans the full range of tank waste characteristics. As documented in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510), a data gap analysis will assess the need for further design capability based on the initial Waste Acceptance Criteria (WAC) for WTP, Tank Farm sampling system capabilities, and projected WTP feed characteristics.
   - Assessment of sampling system performance and gap analysis (IP Commitment 5.4.3.9; Target Completion Date Upon completion of commitment 5.4.3.8 plus 6 months).
   - Physical properties important to mixing and scaling (IP Commitment 5.2.3.1; Target Completion Date May 1, 2012).
6. (IN PROGRESS) Identify waste simulant physical properties that are important to the mixing and scaling studies. As documented in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510), an assessment of physical properties will be performed to determine which characteristics are important to testing.
   - Physical properties important to mixing and scaling (IP Commitment 5.2.3.1; Target Completion Date May 1, 2012).
7. (ONGOING) Include consultation and reviews from a panel of mixing experts in the development of simulants. The simulant design basis will be documented in a simulant report and reviewed by the ERT.
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

Issue Closure:

Following completion of the listed actions: the Physical properties important to mixing and scaling document; and simulant qualification reports will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 10 *The Preliminary Criticality Safety Evaluation Report (CSER, WTP-CSER-ENS-08-001, Rev 0b) needs to be revised and include workable and validated methods for criticality controls.*

Status:

Accepted, open. Updated hazard analyses, conducted on a system-by-system basis, are in progress and include addressing the criticality safety issues associated with potential inventories of large plutonium particles in waste streams. The Criticality Safety Evaluation Report (CSER) will continue to be updated as knowledge of tank waste characterization and waste processing capabilities progresses.

Background:

M3 results from testing completed in 2010 support the CSER basis for a large majority of the Hanford tank waste. The existing CSER addresses the plutonium co-precipitated with various neutron absorbers, and the small plutonium particles (e.g., < 10 microns) are not projected to change the required approach; however, results are not complete for design verification. Sludge composite samples taken of specific Tank Farm waste have revealed the presence of some large discrete PuO_2 particles. The studies of the sludge composite samples are documented in *Distribution of Plutonium-Rich Particles in Tank 241-SY-102 Sludge* (24590-CHG-BNI-2001-01-00001, Rev. A). These discrete PuO_2 forms present a concern that some of these large particles are capable of separating from the neutron absorbing particles that are normally co-precipitated with the plutonium. DOE and its Criticality Safety Support Group (CSSG) identified the need to follow-up on the CSER open item that relates to impact of potential presence of significant amounts of large plutonium particles in the WTP waste feed stream.

Actions to Resolve:

1. (COMPLETE) Update the CSER with the most current criticality knowledge for WTP. The *Preliminary Criticality Safety Evaluation Report (CSER) for the WTP* (24590-WTP-CSER-ENS-08-0001, Rev. 0) currently lists 2 criticality safety limits, which are incorporated into the authorization basis as WTP technical safety requirements.
   - Update the CSER (IP Commitment 5.1.3.4; Target Completion Date December 31, 2012).
2. (IN PROGRESS) Conduct hazard analyses to identify hazards associated with the WTP design evolution since the last hazard evaluation. Hazard analyses are continuing by system. These hazard analyses also address the criticality safety issues associated with potential inventories of large plutonium particles in some waste streams.
   - Heel Management System hazard analysis (IP Commitment 5.6.3.4; Target Completion Date March 30, 2013).
   - *Key Inputs, Assumptions, Safety Margin Uncertainties, and Nuclear Safety Parameters Required to be Included in the Waste Acceptance Criteria* (24590-WTP-RPT-ENS-11-021, Rev. 0) (IP Commitment 5.7.3.4; Issued January 15, 2012).
   - The results of the hazards analyses are documented in updates to *Hazards Analysis Report for the WTP Pretreatment Facility* (24590-PTF-HAR-ENG-11-0002).
3. (IN PROGRESS) Assess the need for further design capability to process waste beyond the current design basis. A data gap analysis will assess the need for further design capability based on the initial Waste Acceptance Criteria (WAC) for WTP, Tank Farm sampling system capabilities, and projected WTP feed characteristics.
   - Assessment of sampling system performance and gap analysis (IP Commitment 5.4.3.9; Target Completion Date six months after completion of the Integrated testing report, IP Commitment 5.4.3.8).
4. (IN PROGRESS) Continue to update the CSER, as needed, with the expansion of criticality knowledge for WTP. One of the commitments in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510) is to update the CSER to address the emerging information related to PuO_2, particle size, particle size distribution, and density.
   - Update the CSER (IP Commitment 5.1.3.4; Target Completion Date December 31, 2012).
   - Criticality sampling requirements will be developed in an updated version of the preliminary CSER. Develop criticality sampling requirements (IP Commitment 5.4.3.3; Target Completion Date December 31, 2013).

5. (IN PROGRESS) Test the heel management system design and the capability of pulse jet mixed vessels to process the full range of tank waste characteristics. Initial plans for Large Scale Integrated Testing to demonstrate performance of the safety function of no solids accumulation according to the design basis as documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
    - Develop test plan (IP Commitment 5.1.3.6; Target Completion Date 15 days in advance of conducting tests).
    - Analysis of test results (IP Commitment 5.1.3.7; Target Completion Date nine months after completion of the test series).
    - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updated information from the IP] (IP Commitment 5.1.3.1; Target Completion Date August 1, 2012).
6. (IN PROGRESS) Conduct an independent review of the TOC and WTP criticality safety bases as it relates to WTP vessel mixing. DOE Criticality Safety Support Group (CSSG) conducted reviews of the TOC criticality safety technical bases, the results of pulse jet mixing studies, and the implications on the criticality safety basis.
    - CSSG's findings are reported in *Criticality Safety Recommendations from the Criticality Safety Support Group (CSSG)* (CCN 215316).
    - The plans and recommendations to address the CSSG recommendations are documented in *Plan of Action to Address Recommendations of the Criticality Safety Support Group* (24590-WTP-RPT-ENS-10-007, Rev. 1).

Issue Closure:

Following completion of the listed actions: the updated CSER will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 11 *Sampling strategies for PJM vessels need to be demonstrated with characterization of sampling uncertainty.*

Status:

Accepted, open. LSIT will include sampling capability testing. The DQO for internal sampling are under development.

Background:

Per Contract Modification No. 221, *Change Order for Large Scale Testing*, a detailed objective for the LSIT is confirmation of integrated pulse jet fluidics, mixing, sampling, and transfer system operations. The operation of PJMs requires the ability of the integrated system to function together with the ability to mix waste, release gases, and transfer waste out of the vessel while simultaneously monitoring the vessel inventory.

Actions to Resolve:

1. (COMPLETE) Document the initial WTP sampling requirements.
    - Currently planned sampling and analysis requirements are collected in the WTP *Integrated Sampling and Analysis Requirements Document (ISARD)* (24590-WTP-PL-PR-04-0001, Rev. 2).

2. (COMPLETE) Document the design of the WTP sampling system. The ASX system interfaces with every major WTP process system and waste system that will be operated in the PTF, HLW, and LAW facilities.
   - The sampling system is described in the *System Description for the Autosampling System (ASX)* (24590-WTP-3YD-ASX-00001, Rev. 1).
3. (IN PROGRESS) Test and document sampling system performance and capability. The plan for sampling capability testing is documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
   - Sampling system test plan (IP Commitment 5.4.3.6; Target Completion Date 15 calendar days in advance of conducting tests).
   - Integrated testing report (IP Commitment 5.4.3.8; Target Completion Date Upon completion of integrated testing data report, plus 8 months).
4. (IN PROGRESS) Demonstrate the ability to obtain representative samples from WTP vessels. In Sub-recommendation 4 in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510) commitments are made to establish sampling requirements; define simulants; test, document, and evaluate system performance and capabilities; and align system capabilities with sampling requirements.
   - Assessment of sampling system performance and gap analysis (IP Commitment 5.4.3.9; Target Completion Date Upon completion of commitment 5.4.3.8 plus 6 months).
5. (IN PROGRESS) Determine location and decision rules for results of the required samples to meet plant safety and process control requirements. ISARD sample locations and decision rules for sampling results will be included in data flow diagrams developed by the Batch Processing Team (*Charter for the Batch Processing Team* – 24590-WTP-CH-OP-10-001, Rev. 1). The Batch Processing Team has been chartered to establish the methodology for performing batch processing at WTP.
   - WTP sampling requirement input considering tank farm sampling capability (IP Commitment 5.4.3.2; Target Completion Date September 30, 2012).
   - Identify sampling requirements to support definition of required sampling system testing (IP Commitment 5.4.3.1; Target Completion Date December 30, 2013).
6. (IN PROGRESS) Utilize a DQO process in conjunction with an uncertainty methodology to assess sources of error, required confidence levels, and analysis methods for planned WTP sampling. Currently planned WTP sampling is identified in *Integrated Sampling and Analysis Requirements Document (ISARD)*.
   - WTP process control sampling requirements (IP Commitment 5.4.3.4; Target Completion Date September 30, 2012).
   - Optimized WAC DQO (IP Commitment 5.5.3.10; Target Completion Date May 31, 2015).

7. (IN PROGRESS) Assess the need for further design capability to process waste beyond the current design basis. The gap analysis will be based on the initial Waste Acceptance Criteria (WAC) for WTP, Tank Farm sampling system capabilities, and projected WTP feed characteristics.
   - Evaluation of waste transferred to WTP (IP Commitment 5.5.3.2; Target Completion Date June 30, 2012).
   - Initial gap analysis between WTP WAC and tank farm sampling and transfer capability (IP Commitment 5.5.3.1; Target Completion Date December 31, 2012).
   - Update the WAC based on LSIT results (IP Commitment 5.5.3.3; Target Completion Date 12 months after completion of final LSIT test report).
   - Gap Analysis (IP Commitment 5.5.3.9; August 31, 2014).
8. (ONGOING) Update the WTP sampling requirements as new process control and safety information is gained. Regulatory compliance strategy and integrated plant operating strategy are evolving, and consequently the ISARD is a living document and will be updated as needed.
   - One example of an anticipated update to the ISARD relates to the IP Commitment, Sampling required to maintain safety design basis (IP Commitment 5.4.3.5; Target Completion Date March 30, 2013).

Issue Closure:

Following completion of the listed actions: the sampling system requirements documents; and sampling system testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 12 *Design confirmation for PJM vessels should not be based only on CFD simulations but also should include full scale or near full scale experimental demonstration of critical performance aspects of PJM vessels containing Newtonian and non-Newtonian slurries.*

Status:

Accepted, open. A variety of actions are planned, including large scale integrated testing and development of a scaling method, to demonstrate that pulse jet mixing and transfer systems will perform adequately at full scale.

Background:

WTP Contract Modifications 199 and 221, *Change Order for Large Scale Testing*, were issued to include execution of Large Scale Testing (LSIT) in the Scope of Work for WTP. Per the contract modification, the required testing includes:

1) Substantiation of the committed design;
2) Engineering, procurement, and construction risk reduction;
3) Design confirmation including benchmarking or validating Computational Fluid Dynamic models and low order models;
4) Waste Treatment and Immobilization Plant commissioning risk reduction.

One detailed objective included in Contract Modification No. 221 is confirmation of scaling parameters for both non-Newtonian and Newtonian vessels. A scaling method is also being developed to gain confidence in the vessel and mixing designs.

Actions to Resolve:

1. (COMPLETE) Document the actions planned to address vessel design areas in need of greater study.
   - A variety of actions are planned, including large scale integrated testing, and are outlined in the Executive Summary of *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510) to demonstrate that pulse jet mixing and transfer systems will perform adequately at full scale.
2. (IN PROGRESS) Document the overall strategy and bases for near full scale testing. The *Integrated Pulse Jet Mixed Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1) documents the initial plans and bases for near full scale testing. Large Scale Testing activities will support design verification and include prototypic testing to demonstrate certain vessel design features.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updated information from the IP] (IP Commitment 5.1.3.1; Target Completion Date August 1, 2012).
   - Vessel configurations for testing (IP Commitment 5.1.3.14; Target Completion Date April 30, 2012).
3. (IN PROGRESS) Identify the areas requiring use of CFD to advance the PJM design. The initial plan for use of CFD Modeling for design confirmation is described in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1). Performance aspects that are not currently planned to be included in CFD analysis include PJM controllability, heel removal, vessel pump-out, and mixing of non-Newtonian fluids.
   - Assessment of whether CFD has required precision (IP Commitment 5.3.3.9; Target Completion Date August 31, 2013).
4. (IN PROGRESS) Identify the areas requiring use of large scale testing to advance the PJM design. The current plan for LSIT is described in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
   - Documented test objectives (IP Commitment 5.1.3.10; Target Completion Date 15 calendar days in advance of conducting tests).
5. (IN PROGRESS) Develop a scaling method to serve as another means of gaining confidence in the WTP PJM design. PNNL has been engaged to support PJM design advancement with responsibility for the scaling basis document.
   - Scaling Basis (IP Commitment 5.1.3.13; Target Completion Date April 30, 2012).

6. (IN PROGRESS) Identify the technical and safety related risks that remain unresolved upon completion of the large-scale testing and establish risk management strategies. Tests will include prototypic PJM configurations and will confirm scale factor exponents used to perform reduced scale tests to assess the ability to predict performance at full scale. The determination of the need to test larger vessels will be assessed based on success and confidence demonstrated in predictions of performance in the 14 ft test vessel.
   - Establish the plan and schedule to systematically evaluate the hazards of known technical issues, M3 vessel assessment summary reports, LOAM benchmarking data, and LSIT results (IP Commitment 5.7.3.1; Target Completion Date January 30, 2012 and updated no less than annually until closure of the IP).
   - Decision point on the need for larger scale testing (IP Commitment 5.1.3.15; Target Completion Date eight months after completion of select test reports).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Recommendation 13 *A separate, focused CFD V&V plan should be developed for PJM vessel performance and should include validation using the results of near full scale or full scale experiments.*

Status:

Accepted, open. A CFD V&V plan has been issued and reviewed by external experts for PJM mixing applications. The plan includes execution of testing in an 8 ft diameter test vessel to provide experimental data required for V&V of the FLUENT model.

Background:

Software Life Cycle Documentation (SWLCD) for FLUENT Volume 4 (24590-WTP-SWLCD-M-10-0001-04, Rev. A) was issued (latest version issued in April 2011) to satisfy a commitment to DOE to issue a V&V Plan for FLUENT in PJM mixing applications and to capture the activities required to finalize the software requirements and test plan. This Volume 4 sets forth a test plan that conforms to American Society of Mechanical Engineers standard (ASME V&V 20-2009), *Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer*, as detailed in *The V&V Plan for Computational Fluid Dynamics Modeling of the PJM Vessels for the Hanford Tank Waste Treatment and Immobilization Plant Project* (24590-WTP-PL-ENG-11-0002, Rev. B). Development of 24590-WTP-PL-ENG-11-0002 was guided by an independent consultant who is a member of the ASME V&V 20-2009 Standard committee.

Actions to Resolve:

1. (COMPLETE) Document requirements and plans for verification and validation (V&V) of FLUENT software for WTP PJM applications.
   - *Software Life Cycle Documentation (SWLCD) for FLUENT Volume 4* (24590-WTP-SWLCD-M-10-0001-04, Rev. A) documents the software requirements, requirements traceability matrix, and software hazard and risk analysis, and to establish a test plan that will verify and validate use of the FLUENT software in PJM applications.
2. (COMPLETE) Procure the additional resources required to meet the needs of PJM modeling in CFD.
   - To facilitate the V&V test case CFD calculations, two new high-performance computers, each comprising 400 dual-core CPU in a rack-configuration parallel system, have been procured.
   - Six additional ANSYS-FLUENT licenses with complete parallel solution capability are licensed to run on the system.
3. (COMPLETE) Determine the adequacy of experimental data already available in meeting the needs of CFD model V&V requirements. At near-full scale there are existing datasets based on solids loading and non-solids loading experiments. At near-mid-scale there are existing datasets from solids loading experiments and non solids-loading experiments. However, there are gaps in the waste properties and other parameters such as simulant particle distribution.
   - *Experimental Data Gap Analysis for CFD Verification and Validation* (24590-WTP-RPT-ENG-11-152, Rev. 1) documents the available experimental data sets that might be used in the V&V effort associated with the FLUENT CFD code applied to the WTP pulse jet mixed vessels.
4. (IN PROGRESS) Ensure experimental data is available to meet the needs of CFD V&V. Testing is being planned to provide the data necessary to complete CFD V&V as identified in *Experimental Data Gap Analysis for CFD Verification & Validation* (24590-WTP-RPT-ENG-11-152, Rev. 1).
   - Decision on need for LSIT to support CFD V&V (IP Commitment 5.3.3.6; Target Completion Date July 31, 2012).
5. (IN PROGRESS) Complete V&V for PJM vessel mixing using experimental data. An approach for complete V&V of computational models is documented in *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510) including development of a V&V plan, completing V&V of the CFD software, comparison of CFD outputs against selected LSIT results, external reviews, and conduct of a gap analysis with identification of additional testing or data needs.
   - Complete V&V of CFD (IP Commitment 5.3.3.7; Target Completion Date October 31, 2012).

6. (ONGOING) Include external expert reviews in planning for CFD use in PJM design confirmation. DOE will utilize the National Energy Technology Lab (NETL) to provide expert assessment of CFD use in PJM design confirmation. Results of these assessments will be used to support conclusions regarding the viability of the plan and approach to use CFD FLUENT for design verification.
   - NETL independent review of data sets to support CFD V&V (IP Commitment 5.3.3.5; Target Completion Date May 30, 2012).
   - External review of complete V&V CFD (IP Commitment 5.3.3.8; Target Completion Date February 28, 2013).
   - Assessment of whether CFD has required precision (IP Commitment 5.3.3.9; Target Completion Date August 31, 2013).

Issue Closure:

Following completion of the listed actions: the CFD V&V completion will be reviewed to verify adequacy in addressing the recommendation.

ATTACHMENT 2
TO
12-WTP-0125

TRANSMITTAL OF DEFENSE NUCLEAR FACILITIES SAFETY BOARD (DNFSB) RECOMMENDATION 2010-2 IMPLEMENTATION PLAN (IP) DELIVERABLE 5.1.3.2

BNI Letter from F. Russo to T. Walton, PNNL, "WTP Response to Vulnerabilities Identified by Pacific Northwest National Laboratory (PNNL)," CCN-243335, dated March 29, 2012.

A-1 - A-20 – Concerns related to the Implementation Plan for DNFSB Recommendation 2010-2 (IP)

B1 – B13 – Additional Concerns (not related to the Implementation Plan for DNFSB Recommendation 2010-2)

Total No. of Pages: 36

Pacific Northwest National Laboratory
Mr. Terry Walton
Director of Energy and Environmental Programs
P.O. Box 999
Richland, WA 99352

CCN: 243335

MAR 2 9 2012

Dear Mr. Walton:

WTP RESPONSE TO VULNERABILITIES IDENTIFIED BY PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL)

References: 1) CCN 243341, Email, from T. L. Walton, PNNL to F. M. Russo, BNI, "Vulnerabilities Identified by PNNL," dated July 6, 2010.
2) CCN 242510, Letter, from D. E. Knutson, DOE-WTP, to R. W. Bradford, BNI, "Implementation Plan for Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2010-2, Pulse Jet Mixing at the Waste Treatment and Immobilization Plant (WTP)," 11-WTP-427, dated December 6, 2011.

This letter is in response to Reference 1 regarding Pacific Northwest National Laboratory's (PNNL) identified vulnerabilities with WTP, transmitted via E-mail from Terry Walton to Frank Russo.

A majority of the vulnerabilities identified by PNNL related to the design of process systems, solids transport concerns, mixing, sampling, and transfer systems. Plans to resolve these issues are to be accomplished by meeting the commitments documented in Reference 2, including large scale integrated testing. Commitments for large scale integrated testing will address PNNL concerns relating to mixing, sampling, transfer systems, and scaling of these systems. Concerns from Reference 1 related to the *Implementation Plan for DNFSB Recommendation 2010-2* are listed in Attachment A, with the specific IP DNFSB 2010-2 commitments that will be used to resolve each issue identified by PNNL.

Additional concerns on the topics of *Plant Process and Solids Transport and Pumping* were identified in Reference 1, but are being addressed outside the Implementation Plan (IP). These topics are listed in Attachment B with specific actions in progress, or completed to close the concern.

WTP will schedule meetings in April 2012 with appropriate PNNL staff to discuss the technical basis and/or approach to closure discussed in the attachments. The objective of these meetings will be to support DNFSB 2010-2 IP Deliverable 5.1.3.3, which requires documentation of PNNL's acceptance of recommendation dispositions. This commitment is due August 1, 2012.

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Richland, WA 99354
tel (509) 371-2000

It is WTP's objective to identify the need for any adjustments to these responses by early May 2012, to facilitate PNNL's acceptance.

For questions, please contact Russell Daniel at (509) 371-3745 or John Olson at (509) 371-3378.

Very truly yours,

Frank Russo
Project Director

JWO/dfo

Attachments: A) Concerns related to the *Implementation Plan for DNFSB Recommendation 2010-2* (IP)
B) Additional Concerns (not related to the *Implementation Plan for DNFSB Recommendation 2010-2*)

cc:

Anderson, S. D. w/o	WTP	MS4-A2
Bradford, R. W. w/o	WTP	MS14-3C
Crawford, S. S. w/a	WTP	MS14-2B
Daniel, R. B. w/o	WTP	MS4-A2
Duncan, G. M. w/o	WTP	MSB1-55
Dunkirk, J. H. w/o	WTP	MS14-3B
French, R. F. w/o	WTP	MS4-B2
Futrell, G. F. w/o	WTP	MS14-2A
Gay, W. W. w/o	WTP	MS4-A2
Gilbert, R. w/o	ORP	H6-60
Hanson, R. L. w/o	WTP	MS4-B2
Harp, B. w/o	ORP	MS14-4A
Julyk, J. w/o	WTP	MS4-A2
Kacich, R. M. w/o	WTP	MS14-3B
Keuhlen, P. w/a	WTP	MS4-A2
Olson, J. w/o	WTP	MS4-A2
Reddick, J. w/o	ORP	H6-60
Russo, F. M. w/o	WTP	MS14-3C
Sawyer, S. L. w/o	WTP	MS14-3C
Scarpino, J. A. w/o	WTP	MS14-3A
Underhill, W. L. w/o	WTP	MS4-A2
Voke, R. w/o	WTP	MS5-G
DOE Correspondence Control w/a	ORP	H6-60
PADC w/a	WTP	MS19-A

Attachment A – Concerns related to the *Implementation Plan for DNFSB Recommendation 2010-2* (IP)

Mixing Concern 1 *Phase 1 of the Newtonian vessel testing (WTP-RPT-182 Pulse Jet Mixing Tests with Noncohesive Solids) that examined the Newtonian vessels, provided examples showing that vessels FRP-02A/B/C/D, HLP-22, PWD-15/16, PWD-33, PWD-44, TCP-01 and UFP-01A/B were substantially underpowered and would not provide bottom clearing using the September 2007 designs. Vessels FEP-17A/B and TLP-09 A/B were shown as marginal.*

Status:
Accepted, open.

Background:
During final testing and analysis activities as part of closure of the M3 technical issue, a number of modifications to the plant were incorporated into the closure documents to reduce WTP operational risk. To further mitigate residual PJM mixing risk, DOE issued contract modifications 199 and 221 that directed large scale integrated testing for PJM-mixed vessels. In parallel, DOE issued a complementary *Implementation Plan for DNFSB Recommendation 2010-2* (IP) (CCN 242510) containing commitments for large scale integrated testing of PJM-mixed vessels using prototypic control and instrumentation, sampling, and transfer systems. Modifications have been initiated to convert the test stand at Mid-Columbia Engineering to allow testing in a larger 8 ft vessel, as well as the existing 4 ft vessel. Design and procurement of a 14 ft test stand and the facility to house it have been initiated.

Actions to Resolve:

1. (COMPLETE) Design changes have been identified and implemented based on EFRT issue M3 Technology Steering Group (TSG) closure records.
   - In FEP-VSL-00017A/B, drive velocity is increased from 8 m/s to 12 m/s and maximum solids concentration is decreased from 5 wt% to 2 wt% by limiting incoming feed streams (CCN 220455).
   - In FRP-VSL-00002B/C/D, drive velocity is increased from 8 m/s to 12 m/s (CCN 220452).
   - In HLP-VSL-00022, the number of PJMs increased from 12 to 18 (CCN 220454) and generated a contract change which includes concentration will not exceed a linear range of 107 grams of unwashed solids/liter at 0.1M Na to 144 grams/liter at 7M Na (WTP Contract Modification M183).
   - In UFP-VSL-00001A/B, the number of PJMs increased from 8 to 12 and drive velocity is increased from 8 m/s to 12 m/s (CCN 220453).
   - M3 closure records for PWD-VSL-00015, -00016, -00033, -00044, and TCP-00001 identified no changes were needed.
2. (COMPLETE) The initial strategy for design verification of the PJM-mixed vessels has been documented.
   - *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).

3. (IN PROGRESS) Continue to review and update the strategy for design verification of the PJM-mixed vessels.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updates from *Implementation Plan for DNFSB Recommendation 2010-2*], IP Commitment 5.1.3.1 (Target Completion Date August 1, 2012).
4. (IN PROGRESS) Address PJM performance capabilities for Newtonian and non-Newtonian configurations using large scale testing.
   - DNFSB 2010-2 Implementation Plan commitments are listed in attachment B of *Implementation Plan for DNFSB Recommendation 2010-2* (CCN 242510).
5. (IN PROGRESS) Develop the test platforms and near full scale testing strategy to support LSIT and development of a scaling basis for design verification of PJM-mixed vessels (including FRP-02A/B/C/D, HLP-22, PWD-15/16, PWD-33, PWD-44, TCP-01, UFP-01A/B, FEP-17A/B, and TLP-09).
   - Scaling Basis, IP Commitment 5.1.3.13 (Target Completion Date April 30, 2012).
   - Vessel configurations for testing, IP Commitment 5.1.3.14 (Target Completion Date April 30, 2012).
6. (IN PROGRESS) Include national laboratory support in the development of the large scale integrated test program.
   - PNNL subcontract under 24590-QL-HC9-WA49-00001, Service Requisition *Technical Support for Large Scale Integrated Testing (LSIT)* (24590-QL-SRA-W000-00160).
   - SRNL subcontract under SCT-M0SRV00028-00, Service Requisition *Initiate SRNL Support of the Large Scale Integrated Test Program* (SCT-M0SRV00028-00-011).
7. (IN PROGRESS) Include consultation and reviews from a panel of mixing experts with varied backgrounds in the development and execution of testing and interpretation of test results.
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Mixing Concern 2 *Phase 2 testing conducted at Mid-Columbia Engineering's Facilities modified the vessel designs and operating conditions (solids concentrations, nozzle velocities, number of PJMs, bottom clearing sequence) for HLP-22, UFP-01, FEP-17 and FRP-02 with the goal of showing the minimum tank requirements for bottom material movement, post-design basis event (DBE) restart, and non-accumulation of solids during pump out could be achieved. The changes to the mixing systems in the vessels appear to "just meet" the minimum tank mixing requirements during the testing. This "Razor's Edge" approach means that any small change in a key testing element could result in a vessel that does not work at full scale in the plant. Engineering choices during the phase 2 testing that cause significant concern (due to designing on the "Razor's Edge") are:*

Mixing Concern 2.a *The simulants used in the testing are not sufficiently bounding of the tank waste properties that are currently documented for the Hanford Waste Tanks (WTP-RPT-153 Estimate of Hanford Waste Insoluble Solid Particle Size and Density Distribution, WTP-RPT-154, Estimate of Hanford Waste Rheology and Settling Behavior, and WTP-RPT-177, An Approach to Understanding Cohesive Slurry Settling, Mobilization, and Hydrogen Gas Retention in Pulsed Jet Vessels).*

Mixing Concern 2.a.1 *The Plutonium oxide simulant particle used in phase 2 testing for HLP-22 and FEP-17 was sized to be 10 micron (using a 12 micron sieve cut) where in actual waste images, 4 of the 18 Pu particle photos (WTP-RPT-153) displayed particles that were over 10 microns (with one being a 23 micron sphere).*

Mixing Concern 2.a.2 *The design basis event (DBE) simulant formulation required a layer of solids at a concentration of ~67% solids concentration to achieve the "reasonable minimum upper bound" of 200 Pa shear strength within 24 hours. This simulant did not exhibit cohesive properties which is different from many of the actual waste sludge materials which do exhibit cohesive behavior. The non-cohesive simulant means the post-DBE simulant is expected to behave differently in mixing and mobilization tests than highly cohesive simulant (WTP/RPP-MOA-PNNL-00494 Recipes for Simulant Strengths).*

Mixing Concern 2.b *The phase 2 of the Newtonian testing program established the nozzle velocities for Pulse Jet Mixers (PJM) by using scaling factors to adjust from the test vessel size to the full vessel diameter in the WTP. The scaling factor used for the zone of influence bottom movement tests was based on the Poreh (1967) work that conducted testing under significantly different conditions. Recent analysis by PNNL for potential non-Newtonian tank testing for WTP (WTP/RPP-MOA-PNNL-00507) have identified significant technical weaknesses in using Poreh (1967) based scaling factors for the testing conditions being used at the MCE test facility.*

Mixing Concern 2.c *The transfer/sampling system used at MCE's test facility is not geometrically scaled and functionally prototypic. The technical basis (or even the sampling bias) for using the system to collect data (that prove that solids do not accumulate during vessel pump-outs) has not been developed. The scaling of the transfer system and the related concerns are in WTP/RPP-MOA-PNNL-00507 (Test Considerations for the Potential Engineering Scale HLP-27 Test).*

Status:

Accepted, open.

Background:

The Preliminary Documented Safety Analysis documents the Safety Class structures, systems, and components (SSCs) at the functional level specifically identified in the DBE analysis. A variety of activities are planned for PJM-mixed vessel to verify the design meets the safety and functional requirements including performance testing, development of a scaling basis, and development of simulants representative of the full range of characteristics of tank waste that may be transferred to WTP. Plans for design margin testing as part of LSIT are documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy*. PNNL is preparing a scaling report that addresses all scaling assumptions (e.g., PJM velocity, vessel geometry, pump suction) and their bases to be used in testing. Constituents will be selected to mimic key parameters important to vessel mixing, including slurry bulk density, slurry rheology, particle density, particle size, and particle size distribution. WTP and SRNL will be developing the simulant basis documents for multi-component Newtonian and non-Newtonian materials to be used during large scale integrated testing. Simulant qualification and analyses will be performed to ensure particle size distribution (PSD) requirements are met. These analyses are being completed by PNNL to support simulant qualification for CFD V&V testing.

Actions to Resolve:

1. (COMPLETE) The determination of PJM-mixed vessels requiring safety class (SC) mixing due to hydrogen retention and release safety concerns is documented.
   - HLP-22, UFP-01, FEP-17, and FRP-02 are among the vessels requiring SC mixing (*Preliminary Documented Safety Analysis – Control Strategy Changes to the PT Facility* – 24590-WTP-PSARA-ENS-09-0001, Rev. 6).
2. (IN PROGRESS) Include study of mixing system design capabilities and margins in the plans for LSIT.
   - Develop test plan, IP Commitment 5.1.3.6 (Target Completion Date 15 days in advance of conducting tests).
3. (IN PROGRESS) Determine the minimum acceptable PJM operating conditions using design margin testing and compare against current design requirements.
   - Analysis of test results, IP Commitment 5.1.3.7 (Target Completion Date nine months after completion of the test series).
4. (IN PROGRESS) Assess the need for further design capability to process waste beyond the current design basis for Tank Farm sampling system capabilities, projected WTP feed characteristics, and initial Waste Acceptance Criteria (WAC) for WTP.
   - Initial gap analysis between WTP WAC and tank farm sampling and transfer capability, IP Commitment 5.5.3.1 (Target Completion Date December 31, 2012).
   - Assessment of sampling system performance and gap analysis, IP Commitment 5.4.3.9 (Target Completion Date six months after completion of the integrated testing report).
   - Results from Tank Farm performance testing, IP Commitment 5.5.3.7 (Target Completion Date March 31, 2013).
   - Gap Analysis, IP Commitment 5.5.3.9 (Target Completion Date August 31, 2014).

Actions to Resolve 2.a, 2.a.1, and 2.a.2:

5. (IN PROGRESS) Include technical expertise from the national laboratories and from the mixing industry in development and review of the simulant design basis and scaling basis.
   - PNNL subcontract under 24590-QL-HC9-WA49-00001, Service Requisition *Technical Support for Large Scale Integrated Testing (LSIT)* (24590-QL-SRA-W000-00160).
   - SRNL subcontract under SCT-M0SRV00028-00, Service Requisition *Initiate SRNL Support of the Large Scale Integrated Test Program* (SCT-M0SRV00028-00-011).
6. (IN PROGRESS) Include consultation and reviews from a panel of mixing experts with varied backgrounds in the development and execution of testing, interpretation of test results, development of simulant basis documents, and development of the LSIT scaling basis.
   - *Charter for the Large Scale Integrated Mixing System Expert Review Team* (24590-WTP-CH-MGT-11-001, Rev. 2).

7. (IN PROGRESS) Update and define (as needed) functional requirements related to criticality safety and retention and release of flammable gas.
   - Define and document functional requirements, IP Commitment 5.1.3.5 (Target Completion Date 15 days in advance of conducting tests).
8. (IN PROGRESS) Define test objectives to meet testing needs (including shearing of waste for remobilization, pump-out, and sampling).
   - Documented test objectives, IP Commitment 5.1.3.10 (Target Completion Date 15 days in advance of conducting tests).
9. (IN PROGRESS) Determine the required criteria to be considered in selection of non-Newtonian and Newtonian simulants to ensure the basis spans the full range of tank waste characterization.
   - Physical properties important to mixing and scaling, IP Commitment 5.2.3.1 (Target Completion Date May 1, 2012).
10. (IN PROGRESS) Develop simulant basis documents including justification for the simulant component selected to represent waste PuO_2 particles, and verify the accuracy and completeness of simulant design bases.
    - Qualification report for selected simulants, IP Commitment 5.2.3.2 (Target Completion Date 15 days in advance of conducting tests).
11. (IN PROGRESS) Update the Criticality Safety Evaluation Report (CSER) with updated waste characterization information related to PuO_2.
    - Update the CSER, IP Commitment 5.1.3.4 (Target Completion Date December 31, 2013).

Actions to Resolve 2.b:

12. (IN PROGRESS) Develop scaling laws that predict mixing performance at full-scale.
    - Scaling Basis, IP Commitment 5.1.3.13 (Target Completion Date April 30, 2012).
13. (IN PROGRESS) Select test vessel platform configurations that will support confirmation of Newtonian and non-Newtonian PJM-mixed vessel scaling parameters.
    - Vessel configurations for testing, IP Commitment 5.1.3.14 (Target Completion Date April 30, 2012).
    - Decision point on the need for larger scale testing, IP Commitment 5.1.3.15 (Target Completion Date eight months after completion of reports on stand-alone instrumentation and control tests).

Actions to Resolve 2.c:

14. (COMPLETE) Initial WTP sampling requirements are documented.
    - *Integrated Sampling and Analysis Requirements Document* (24590-WTP-PL-PR-04-0001, Rev. 2).

15. (IN PROGRESS) Perform sampling system testing to obtain performance data and update sampling requirements.
    - WTP process control sampling requirements, IP Commitment 5.4.3.4 (Target Completion Date September 30, 2012).
    - Sampling required to maintain safety design basis, IP Commitment 5.4.3.5 (Target Completion Date March 30, 2013).
    - Sampling system test plan, IP Commitment 5.4.3.6 (Target Completion Date 15 days in advance of conducting tests).
    - Initial sampling system test reports, IP Commitment 5.4.3.7 (Target Completion Date eight months after completion of initial sampling system test data report).
16. (IN PROGRESS) Demonstrate integrated operation of prototypic mixing, sampling, and transfer operations.
    - Integrated testing report, IP Commitment 5.4.3.8 (Target Completion Date eight months after completion of integrated testing data report).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Mixing Concern 3 *The mixing systems in the non-Newtonian vessels were developed with some design margin but testing was directed at what was thought at the time to be the most challenging mixing requirement: that is the mixing of non-Newtonian slurries with rheological properties at the expected upper bound. Recently some concern has been raised by others that the vessels may at times contain slurries that exhibit Newtonian rheology. Limited data was obtained in the non-Newtonian test program with glass beads in water to assess the solids suspension capabilities of the mixing systems in the non-Newtonian vessels. It is unclear at this time if this data set is sufficient to form a design basis for the non-Newtonian vessels.*

Status:

Accepted, open.

Background:

M3 assessments provided an initial analysis of capability of the non-Newtonian vessels to mix and transfer the range of waste characteristics that meet the design basis. Large scale integrated testing will be used (in part) to verify the design of the non-Newtonian PJM-mixed vessels. Heel management testing will be performed under a range of conditions that go beyond the design basis to demonstrate the extent of flexibility added to the design with heel dilution and removal capability. Simulants used for testing will be qualified to represent the full range of design basis characteristics. Waste that challenges the planned WTP operations will be identified through waste pre-qualification testing, and an efficient processing plan will be developed for each waste feed.

Actions to Resolve:

1. (COMPLETE) A plan has been documented to estimate the performance of the WTP unit operations (e.g. leaching), address uncertainty in waste characteristics, and determine the appropriate processing of waste feeds. (Note that this action is closed since the purpose is to explain that waste is pre-qualified to estimate performance of process operations.)
   - *Plan for WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).
2. (COMPLETE) Methods for controlling slurry rheology of post-leached/washed solids have been documented and include limiting the extent of leaching, limiting the extent of washing, and/or varying the solids concentration, where solids concentration has the largest impact on rheology.
   - *Slurry Property Ranges in Non-Newtonian Pretreatment Vessels at WTP* (24590-WTP-RPT-PET-10-014, Rev. 2) also suggests that monitoring for rheology may utilize permeate flux rates, pressure drop, and/or pump amperage. Samples can be collected at the UFP-01A/B or UFP-02A/B vessels and analyzed to determine the rheology properties, but this is not a required sample currently.
   - Methods of monitoring rheology were deemed acceptable as documented in *SRNL - Independent Technical Review of WTP's Assessment of Non-Newtonian Vessel Performance* (CCN 218916).
3. (COMPLETE) An initial assessment of the current design capability to mix and transfer feeds that meet the design basis has been documented.
   - *EFRT Issue M3 PJM Vessel Mixing Assessments* (24590-WTP-RPT-ENG-08-021-01 through -10).
4. (IN PROGRESS) Perform large scale integrated testing to assess PJM-mixed vessel capability to mix and transfer simulants representing the full range of expected waste characteristics of feeds transferred from tank farms to WTP and the design basis.
   - Integrated testing report, IP Commitment 5.4.3.8 (Target Completion Date eight months after completion of integrated testing data report).
5. (IN PROGRESS) Determine the added flexibility provided by the heel management system to process waste that exceeds the design basis.
   - Heel Management test plan, IP Commitment 5.6.3.6 (Target Completion Date 15 days prior to conducting tests).
   - Heel Management test report, IP Commitment 5.6.3.7 (Target Completion Date nine months after completion of test series).
6. (IN PROGRESS) Include relevant mixing performance and the full range of design basis characteristics in the LSIT Newtonian and non-Newtonian simulant selection.
   - Physical Properties important to mixing and scaling, IP Commitment 5.2.3.1 (Target Completion Date May 1, 2012).
   - Qualification report for selected simulants, IP Commitment 5.2.3.2 (Target Completion Date 15 days in advance of conducting tests).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Mixing Concern 4 *PJM Technology: There has been a fundamental misperception about the maturity of PJM technology. This is new technology which is unproven for applications involving significant amounts of solids. This combination of new technology and solids was noted as particularly challenging at a workshop on Slurry Retrieval, Pipeline Transport & Plugging, and Mixing.*

Status:

Accepted, open.

Background:

The *Technology Maturation Plan for the Waste Treatment and Immobilization Plant* (DOE/ORP-2007-02) identified PJM technology as a WTP critical technology element (CTE). ORP has directed WTP to achieve Technology Readiness Level 6 (technology demonstration using a prototypic pilot-scale test platform in a relevant environment), for PJM technology prior to the finalization of the design. Initial plans for the development of the PJM design and controls has been documented in *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1). Current plans include testing on 4-ft, 8-ft, and 14-ft diameter vessel test platforms. Following completion of specified testing, the need for testing on a larger scale will be evaluated based on documented criteria.

Actions to Resolve:

1. (COMPLETE)A Technology Readiness Assessment for the WTP has been completed and includes PJM technology in the assessment.
   - *Technology Maturation Plan for the Waste Treatment and Immobilization Plant* – DOE/ORP-2007-02.
2. (COMPLETE) The initial strategy for design verification of the PJM-mixed vessels has been documented.
   - *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
3. (IN PROGRESS) Continue to review and update the strategy for design verification of the PJM-mixed vessels.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updates from *Implementation Plan for DNFSB Recommendation 2010-2*], IP Commitment 5.1.3.1 (Target Completion Date August 1, 2012).
4. (IN PROGRESS) Perform integrated testing of the vessel mixing and transfer systems in near full-scale prototypic conditions.
   - Integrated testing report, IP Commitment 5.4.3.8 (Target Completion Date eight months after completion of integrated testing data report).

5. (IN PROGRESS) Upon completion of planned testing, assess the need for testing on a scale larger than 14-ft diameter using specific technical criteria to support the decision.
   - Decision point on the need for larger scale testing, IP Commitment 5.1.3.15 (Target Completion Date eight months after completion of reports on select tests including integrated 14-ft testing).
   - Larger scale testing decision criteria, IP Commitment 5.1.3.16 (Target Completion Date eight months after completion of reports on select tests including integrated 14-ft testing).
6. (IN PROGRESS) Develop Pulse Jet Mixing computational fluid dynamics (CFD) analysis capability to contribute to technology maturation.
   - Complete V&V of CFD, IP Commitment 5.3.3.7 (Target Completion Date October 31, 2012).
   - CFD analysis of planned LSIT, IP Commitment 5.3.3.11 (Target Completion Date August 31, 2013).
   - CFD prediction of LSIT performance assessment, IP Commitment 5.3.3.12 (Target Completion Date eight months after completion of reports on selected comparison tests).

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Solids Transport and Pumping Concern 2 *The Bismuth Phosphate wastes have shown that they can gel (WTP-RPT-166 in the CUF Run), Crystallize (with significant temperature changes) and precipitate when exposed to high sodium levels. Wastes containing relatively high concentrations of phosphate have the potential to plug lines and disrupt the mixing process. Laboratory tests with actual waste samples show that these wastes settle rapidly (~ 1 hr). Shear strength measurements indicate that the shear strength after 72 hours could range as high as 1500 Pa (WTP-RPT-167, Characterization and Leach Testing for PUREX Cladding Waste Sludge (group3) and REDOX Cladding Waste Sludge (Group4) Actual Waste Sample Composites) which is well above the 200 Pa shear strength targeted in recent Phase 2 mixing tests.*

Status:

Accepted, open.

Background:

Potential for waste that may gel, crystallize, or precipitate has been evaluated and design changes to manage the issue have been implemented. In the Equipment Option, precipitation is minimized by a combination of temperature control, minimization of concentration changes, and caustic/water addition (CCN 216051). Waste that challenges the planned WTP operations will be identified through waste pre-qualification testing, and an efficient processing plan will be developed for each waste feed.

Actions to Resolve:

1. (COMPLETE) WTP has evaluated and addressed the potential for post-filtration precipitates in the Pretreatment facility.
   - *Recommendation of Alternative to Mitigate Solids Precipitation in Ion Exchange Feed* (24590-WTP-RPT-PET-09-004, Rev. 1).
2. (COMPLETE) A design change has been selected by DOE and implemented by WTP titled the "Equipment Option" which minimizes post-filtration precipitation by a combination of temperature control, minimization of concentration changes, and caustic/water addition.
   - *DOE-ORP Selection of Alternative for Mitigating Post-Filtration Precipitation in Cesium Ion Exchange System in the Pretreatment Facility* (CCN 216051).
3. (COMPLETE) A plan has been documented to estimate the performance of the WTP unit operations (e.g. leaching), address uncertainty in waste characteristics, and determine the appropriate processing of waste that may gel, crystallize, or precipitate. (Note that this action is closed since the purpose is to explain that waste is pre-qualified to estimate performance of process operations.)
   - *Plan for WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).
4. (IN PROGRESS) LSIT includes testing to demonstrate solids remobilization and release of flammable gas (applicable to both abnormal and accident conditions). Testing will be performed on non-Newtonian and Newtonian platforms.
   - Develop Test Plan, IP Commitment 5.1.3.6 (Target Completion Date 15 days prior to conducting test).
   - Analysis of Test Results, IP Commitment 5.1.3.7 (Target Completion Date nine months after completion of test series).
5. (IN PROGRESS) There is testing and evaluation planned as a result of the process operating limits gap assessments completed per External Flowsheet Review Team (EFRT) issues M6 (Process Operating Limits Not Completely Defined) and P4 (Potential Ultrafiltration/Leaching Issue - Gelation & Precipitation).
   - Testing is planned to evaluate the potential for Precipitation at Operating Limits for LAW Concentrate from PTF to LAW per Scoping Statement M6-1 and Section 3.3 of 24590-WTP-PL-RT-07-0002, Rev 0. The tests for this item are being developed to include constituents known to form gels, precipitates that could plate on cool surfaces or higher than expected levels of precipitate that could impact the transfer between PTF and LAW. Since temperatures are maintained in PTF vessels to mitigate potential precipitation, this work focuses on the transfer to LAW.

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; mixing performance testing results; and testing results to evaluate potential for unexpected precipitation in treated LAW concentrate from PTF to LAW will be reviewed to verify adequacy in addressing the recommendation.

Suction Lines Concern 1 *High concentrations of solids in the suction lines cause much higher line losses (several times those provided in WTP-RPT-189) than are incorporated in the current design guide. This problem has increased as the need to fully mix the high concentration waste receipt vessels has been removed and much higher suction pipe input concentrations are now expected. The long suction lengths make this problem critical.*
Suction Lines Concern 1.a *The slow suction line velocities (resulting from the high line pressure loss) are expected to cause inline deposition of high concentration materials.*
Suction Lines Concern 1.b *The design of the positive displacement or Moyno progressing cavity pumps on suction lines with high line losses must evaluate the pressure at key points in the suction pipe. With the receipt vessels being at atmospheric pressure (~ 30 inches Hg), a pressure drop in the suction pipe to 2 inches Hg (or lower including vacuum) will allow the slurry to boil at plant temperatures (~ 80 degrees F). The creation of vapor in the suction lines has long been identified in slurry handbooks as the point where positive displacement pumps may not prime. If vacuum conditions are developed anywhere along the pipe, piping must be designed to handle the vacuum.*
Suction Lines Concern 1.c *Air entrainment at the pump inlet as observed in the PEP ultrafiltration loop at levels that limited pump performance (WTP-RPT-197, Pretreatment Engineering Platform Phase 1 Final Test Report). The entrained air degraded the ability of the pumps to meet the flow requirements.*

Status:
Accepted, open.

Background:
Initial mixing assessments were issued to close the EFRT M3 technical issue and included estimates of peak fluid properties based on PJM mixing performance. Pump and line sizing calculations have been revised (as needed) to incorporate these peak fluid properties determined in M3 mixing assessments and require confirmed fluid property data for design confirmation. WTP engineering calculations are required to comply with the project issued design guides. Minimum critical velocity calculation methods are included in project design guides to preclude deposition, and there are multiple design guides issued to aid engineers in design of slurry transfer lines. Plans for flushing slurry piping have been developed. Pump capability concerning suction design and air entrainment has been reviewed by pump vendors. Expert reviews are to be included in the design process for all Pretreatment pumps due to suction line concerns. Air entrainment at the ultrafiltration loop pump inlet was observed in the PEP testing at levels that limited pump performance. Note, the air entrainment was found only during the flow instrumentation malfunction and when the liquid was operated below the ultrafilter recirculation line nozzle. There was no issue with the ability to control the flow rate when the recirculation nozzle was submerged.

Actions to Resolve:

1. (COMPLETE) Peak fluid properties for the pump and slurry transfer line designs have been estimated and provided as recommendations in the PJM-mixed vessel assessments completed to support closure of the EFRT M3 technical issue.
   - *EFRT Issue M3 PJM Vessel Mixing Assessments* (24590-WTP-RPT-ENG-08-021-01 through -10).
   - Where necessary, engineering calculations have been revised to incorporate peak fluid property recommendations from EFRT Issue M3 closure.
2. (COMPLETE) WTP has issued design guides to aid system engineers in design of slurry transfer lines including methods for calculating minimum slurry critical velocity and transfer piping features to preclude deposition.
   - *Minimum flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A).
   - *Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model* (24950-WTP-GPG-M-016, Rev. 2).
   - *Determination of Pressure Drop for Lines with Liquids Containing Solids – Power Law Fluids* (24590-WTP-GPG-M-039, Rev. 2).
   - *Recommended Slopes for Piping Systems* (24590-WTP-GPG-M-027, Rev. 5).
3. (COMPLETE) WTP design guides include consideration of vapor pressure in specifying NPSHr for pump and transfer systems.
   - *Pump Net Positive Suction Head* (24950-WTP-GPG-M-012, Rev. 3).
   - *Ejector (Jet Pumps) For Liquid Slurry Pumping* (24590-WTP-GPG-M-005, Rev. 2).
4. (COMPLETE) WTP engineering calculations are required to comply with the project issued design guides (or provide justification for exception), which provide the limits for design guide applicability and advice for cases where the limits cannot be met.
   - *WTP Procedures and Guides*, 24590-WTP-GPP-MGT-028.
5. (COMPLETE) The WTP slurry piping design includes flushing following process fluid transfers.
   - *ICD 19 - Interface Control Document for Waste Feed* (24590-WTP-ICD-MG-01-019, Rev. 5).
   - *Engineering Specification for Flushing and Cleaning Requirements for the Startup of Quality and Commercial Fluid Systems in All Facilities* (24590-WTP-3PS-G000-T0018, Rev. 1).

Actions to Resolve 1.a:

6. (COMPLETE) The initial strategy for design verification of the PJM-mixed vessels has been documented.
   - *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
7. (IN PROGRESS) Demonstrate integrated operation of prototypic mixing and transfer operations.
   - Integrated testing report, IP Commitment 5.4.3.8 (Target Completion Date eight months after completion of integrated testing data report).

8. (IN PROGRESS) Continue to review and update the strategy for design verification of the PJM-mixed vessels, including confirmed PJM mixing calculations to ensure slurry transfer system designs are bounding.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updates from *Implementation Plan for DNFSB Recommendation 2010-2*], IP Commitment 5.1.3.1 (Target Completion Date August 1, 2012).
   - Assessment of whether CFD has required precision [to support design verification], IP Commitment 5.3.3.9 (Target Completion Date August 31, 2013).

Actions to Resolve 1.b and 1.c:

9. (COMPLETE) Progressive cavity pump design calculations have been issued for the UFP and the heel management systems based on a bounding minimum liquid level in the vessel and the maximum fluid temperature.
   - *Sizing of the Ultrafiltration Progressive Cavity Pump (UFP-PMP-00044A/B)* (24590-PTF-MPC-UFP-00033, Rev. B).
   - *Sizing of the Vessel Heel Dilution/Cleanout Pump (HLP-PMP-00022)* (24590-PTF-MPC-HLP-00018, Rev. A).
10. (IN PROGRESS) Close the open pump design issues regarding suction design and air entrainment.
   - Pump vendors provided review and recommendations on the pump suction design and air entrainment (*Unresolved Open Potential Issues with Pretreatment Pumps* – 24590-WTP-PIER-MGT-11-0032-C, Action 3)
   - Information provided by pump vendors on air entrainment will be reviewed by the Bechtel pump expert to support closure of the open issues regarding suction design and air entrainment (WTP-PIER-MGT-11-0032, Action 4).
11. (IN PROGRESS) Resolve air entrainment issues with UFP-PMP-00042A/B that were discovered in PEP testing.
   - The recirculation line was redesigned to eliminate the recirculation line end nozzle to keep the velocity same as the return line (10" piping) and to lower the recirculation line below the minimum batch level. These design changes will be shown on the revised vendor drawings for UFP-VSL-00002A/B.

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Plant Process Concern 5 *Process Control – The WTP will also rely upon a process control scheme that includes very limited sampling after waste has left the feed tanks. This lack of process control input will lead to a very conservative approach to process operations. In particular, the control of process rheology will be a significant challenge. Small variation in process performance can produce significant swings in process stream rheology. The proposed rheology control strategy has not been demonstrated and was not part of the PEP demonstration.*

Status:

Accepted, open.

Background:

Rheology monitoring methods were conceptualized in a study documenting the expected non-Newtonian slurry property ranges. SRNL provided an independent technical review of the rheology monitoring plan and agreed with it as a workable concept. The rheology controls have been further detailed in *Rheology Control in UFP* (CCN 230124) and in the UFP system description. The UFP detailed control logic diagrams and enhanced controls addition to the P&IDs are under development.

Actions to Resolve:

1. (COMPLETE) Determine methods to control post-leached/washed solids slurry rheology. Methods for controlling slurry rheology of post-leached/washed solids have been documented and include limiting the extent of leaching, limiting the extent of washing, and/or varying the solids concentration, where solids concentration has the largest impact on rheology.
    - *Slurry Property Ranges in Non-Newtonian Pretreatment Vessels at WTP* (24590-WTP-RPT-PET-10-014, Rev. 2) also suggests that monitoring for rheology may utilize permeate flux rates, pressure drop, and/or pump amperage.
    - Methods of monitoring rheology were deemed acceptable as documented in *SRNL - Independent Technical Review of WTP's Assessment of Non-Newtonian Vessel Performance* (CCN 218916).
2. (COMPLETE) Methods for controlling ultrafiltration processing have been determined. The current control scheme for UFP processing is to use pressure drop over the entire ultrafiltration loop to control when the minimum rheology conditions are achieved. The blending strategy will be determined for each batch of waste based on the feed solids and sodium concentrations.
    - *Rheology Control in UFP* (CCN 230124).
    - *System Description for the Ultrafiltration Process System (UFP)* (24590-PTF-3YD-UFP-00001, Rev. 2).

3. (COMPLETE) The strategy to minimize rheology fluctuations for ion exchange feed has been determined and implemented. The Equipment Option design change included a large, well mixed volume spanning 4 vessels which minimizes impacts of changes in fluid rheology.
   - In *DOE-ORP Selection of Alternative for Mitigating Post-Filtration Precipitation in Cesium Ion Exchange System in the Pretreatment Facility*, DOE directed a change to the WTP design to incorporate the "Equipment Option" to address post-filtration precipitation (CCN 216051).
4. (IN PROGRESS) Develop detailed controls for UFP and issue control logic diagrams and enhanced DCNs.
   - Completion of control logics/DCNs for UFP are scheduled activities.
5. (IN PROGRESS) Determine required sample locations and decision rules. The Batch Processing Team has been chartered to establish the methodology for performing batch processing at WTP including process flow charts indicating required sample locations and decision rules.
   - *Charter for the Batch Processing Team* (24590-WTP-CH-OP-10-001, Rev. 1).

Issue Closure:
Following completion of the listed actions: the UFP enhanced control logic DCN; and process flow charts indicating required sample locations and decision rules will be reviewed to verify adequacy in addressing the recommendation.

Plant Process Concern 7 *Systems Engineering Update Needed - Potential system impacts of changing processes and equipment indicate that a complete systems engineering review is needed to ensure integrated performance and to compare projected performance to processing requirements.*
Plant Process Concern 7.a *For example, in response to the identification of a caustic corrosion issue, the leaching temperature has been dropped from 100 °C to 85 °C. This impacts the rate at which Boehmite is leached. To offset the lower leach temperature, the processing time can be extended, more caustic can be added, or a lower extent of leaching can be accepted (potentially increasing the amount of HLW produced). Another example is the proposed lower rheological operating limit of 6 Pa for yield stress (raised from 1 Pa) in the UFP-2 vessels. This increased limit is being considered to address an uncertainty associated with mixing of settling solids in the "Non Newtonian" vessels and may be achieved by operating at a higher solids concentration limit. This will impact the leaching, washing and filtration operations in the UFP-2 vessel.*

Status:
Accepted, open.

Background:
Robust configuration management controls are used at WTP to ensure procedurally compliant incorporation of design changes. Periodic Operations Research (OR) assessments and Tank Utilization assessments are conducted which estimate the waste treatment capacity of each of the WTP facilities and the integrated WTP facility. The actions completed in implementation of the

Equipment Option are provided below as an example of compliance with the configuration management for design changes. A change to the caustic leach temperature has also been evaluated and implemented into the WTP design in compliance with the configuration management control process. The design of UFP-VSL-00002A/B accounts for the full range of wastes that are expected to be processed in the vessel. Large scale testing to verify the design of the non-Newtonian vessels and demonstrate UFP-VSL-00002A/B across the full range of design conditions is a continuing activity.

Actions to Resolve:

1. (COMPLETE) A configuration management process is followed at WTP to control design changes and ensure coordination between systems. As the design progresses, where the plant process analyses require changes to design requirements, the impacted technical baseline documents used as sources of design criteria are maintained according to their respective procedures. In addition, the Design Criteria Database (DCD) will be updated per procedure (shown in bullet below). Updates to the DCD trigger an evaluation of design impacts by the design organizations. A closed loop process captures whether the change resulted in design impacts.
    - *WTP Configuration Management Plan* (24590-WTP-PL-MG-01-002, Rev. 6A).
    - *Design Criteria* (24590-WTP-3DP-G04B-00001, Section 3.4).
2. (COMPLETE) The P&IDs have been revised to implement the Post-Filtration Precipitation issue resolution (i.e. Equipment Option). *WTP Configuration Management Plan* and other applicable procedures were followed in updating the P&IDs. Note that upper tier design documents (e.g. BOD and PDSA) were assessed for impacts and resolved before proceeding with the P&ID revisions.
    - Relevant P&IDs have been recommitted (ie. for CXP/UFP).
    - Upper tier documents were updated to allow changes (ie. BODCN) or had approval to proceed ahead of AB changes (ie. JCDPI).
3. (IN PROGRESS) Revise the process used to validate requirements prior to their approval in design criteria documents.
    - Actions have been identified (24590-WTP-PIER-MGT-11-0979-B, Rev 0) to revise the process used to validate requirements prior to their approval in design criteria documents. The resulting process will require conducting an analysis to understand the impacts of change and identifying affected design documents prior to approving criteria changes.
4. (ONGOING) Periodic Operations Research (OR) assessments and Tank Utilization assessments are conducted in accordance with the WTP Contract Statement of Work, Standard 2.
    - The OR assessments estimate the waste treatment capacity of each of the WTP facilities and the integrated WTP facility to demonstrate their ability to meet integrated facility capacity and availability requirements.
    - Tank Utilization Assessments support OR assessments of design changes that could affect model outcomes.

Actions to Resolve 7.a

5. (COMPLETE) The Basis of Design (BOD) has been updated for a maximum leaching temperature of 90°C. The BOD change flows down to design using the change control program.
   - *Basis of Design* (24590-WTP-DB-ENG-01-001, Rev. 1Q) has been updated for maximum leaching temperature of 90 °C.
6. (COMPLETE) Integrated ultrafiltration processing when caustic leaching is performed at 98°C and 85°C has been demonstrated.
   - *Pretreatment Engineering Platform Phase 1 Final Test Report* 24590-QL-HC9-WA49-00001-03-00040, Rev. A.
7. (COMPLETE) The reduced caustic leaching temperature is incorporated into the G2 model along with other design changes (e.g. Equipment Option, M3 design changes). The results show a reduction in IHLW canisters and 1 additional year of WTP operation, but contract throughput requirements are still met.
   - *2010 WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. 0).
8. (COMPLETE) Aluminum and chromium leaching are included in the waste pre-qualification unit operations to determine expected process efficiencies prior to waste processing.
   - *WTP Feed Pre-qualification* (24590-WTP-PL-OP-07-0001, Rev. 1).
9. (IN PROGRESS) Develop leaching process steps and obtain DOE approval (ie. obtain approval of Specification 12).
   - Proposed Process Steps for Sludge Treatment, Contract Deliverable Item No. 2.10 in Table C.5-1.1 in *WTP Contract*, DE-AC27-01RV14136 (Completion date is one year before start of cold commissioning for the PTF).
   - Procedure to Determine the Waste Feed Treatment Approach, Contract Deliverable Item No. C.7-1 in Table C.5-1.1 in *WTP Contract*, DE-AC27-01RV14136 (Completion date is one year before start of cold commissioning for the PTF).
10. (IN PROGRESS) Confirm the design of UFP-VSL-00002A/B accommodates the full range of rheologies from Newtonian to non-Newtonian that is due to ultrafiltration processing. The unverified design of UFP-VSL-00002A/B accommodates the full range of design basis fluid properties (i.e. slurry viscosities from 1 cP to 30 cP).
    - *Process Inputs Basis of Design (PIBOD)* (24590-WTP-DB-PET-09-001, Rev. 1)
11. (IN PROGRESS) Testing will be performed under LSIT to inform the design of the non-Newtonian vessels. Waste simulants will be developed for mixing and transfer system testing that reflect the Newtonian and non-Newtonian physical and rheological properties of tank waste.
    - Develop Test Plan, IP Commitment 5.1.3.6 (Target Completion Date 15 days prior to conducting test).
    - Analysis of Test Results, IP Commitment 5.1.3.7 (Target Completion Date nine months after completion of test series).
    - Qualification report for selected simulants, IP Commitment 5.2.3.2 (Target Completion Date 15 days in advance of conducting tests).

12. (IN PROGRESS) There is testing and evaluation planned as a result of the process operating limits gap assessments completed per External Flowsheet Review Team (EFRT) issues M6 (Process Operating Limits Not Completely Defined) and P4 (Potential Ultrafiltration/Leaching Issue - Gelation & Precipitation).
    - The process operating limits gap assessment of the UFP system and UFP interfaces is planned per 24590-WTP-PL-RT-07-0002, Rev 0 Section 3.9.

Issue Closure:

Following completion of the listed actions: the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; mixing performance testing results; and process operating limits gap assessment of the UFP system and UFP interfaces will be reviewed to verify adequacy in addressing the recommendation.

Gas Retention Concern 1 *There are significant uncertainties associated with a lack of quantitative results for PJM mobilization of settling cohesive slurries, and other uncertainties are associated with a lack of information for waste properties needed for quantifying PJM performance and gas retention. (See WTP-RPT-177 An Approach to Understanding Cohesive Slurry Settling, Mobilization, and Hydrogen Gas Retention in Pulsed Jet Mixed Vessels.) The vulnerability that results from these uncertainties is that the PJMs have not been shown to have adequate performance with cohesive solids which could lead to buildup of cohesive solids in the bottom of the vessels that could retain up to 20-30% flammable retained gas.*

Gas Retention Concern 1.a *The first category is Technical Uncertainties for PJM Behavior with Settling Slurries. There is a scarcity of testing data for PJM performance on settled or stratified cohesive layers, and it is unclear if the existing correlations developed for vessels without layers can be used for settling waste. While the previous studies on PJM mixing of uniform non-Newtonian materials quantified many aspects of the PJM performance, data to quantify the roles of important operational parameters (jet velocity, pulse size, and duty cycle) and geometry (number of PJM tubes, nozzle size, bottom shape) are absent.*

Gas Retention Concern 1.b *The second category is Technical Uncertainties for Waste Characterization. The most significant uncertainty is that the existing models and data on settling dynamics and the strength of settled layers have not included experimental testing to confirm the scaling behavior or to determine the increasing strength with depth into a settled layer. It is expected that a sound understanding of settling dynamics will be needed to design, or to determine the operating limits of, a mixing system capable of managing the strength and thickness of settled layers.*

Status:

Accepted, open.

Background:

During final testing and analysis activities as part of closure of the M3 technical issue, a number of modifications to the plant were incorporated into the closure documents to reduce WTP operational risk. The Preliminary Documented Safety Analysis documents the Safety Class SSCs at the functional level specifically identified in the DBE analysis. A variety of activities are planned for PJM-mixed vessels to verify the design meets the safety and functional requirements including design margin testing, development of a scaling basis, development of simulants representative of the full range of characteristics of tank waste that may be transferred to WTP, and verification and validation of a CFD analysis method for Newtonian applications.

Actions to Resolve:

1. (COMPLETE) Initial vessel mixing assessments performed during M3 concluded that each of the Newtonian PJM-mixed vessels (in some cases with modifications) were capable of meeting respective mixing requirements according to the current design basis. Mixing requirements include the ability to mobilize solids and prevent accumulation which might result in build up of gasses resulting from radiolysis or thermolysis.
   - *EFRT Issue M3 PJM Vessel Mixing Assessments* (24590-WTP-RPT-ENG-08-021-01 through -10).
2. (COMPLETE) The initial strategy for design verification of the PJM-mixed vessels has been documented.
   - *Integrated Pulse Jet Mixed Vessel Design and Control Strategy* (24590-WTP-RPT-ENG-10-001, Rev. 1).
3. (IN PROGRESS) Continue to review and update the strategy for design verification of the PJM-mixed vessels.
   - Issue the Integrated Pulse Jet Mixed Design and Control Strategy [with updates from *Implementation Plan for DNFSB Recommendation 2010-2*], IP Commitment 5.1.3.1 (Target Completion Date August 1, 2012).
4. (IN PROGRESS) Include relevant mixing performance and the full range of tank waste characteristics in the LSIT simulant selection. LSIT will test with non-Newtonian slurries (preliminary plans include clay mixtures) in which larger and denser particle spikes have been embedded. Newtonian simulants will be tested as well.
   - Physical properties important to mixing and scaling, IP Commitment 5.2.3.1 (Target Completion Date May 1, 2012).
   - The process waste simulant bases will be developed and a qualification report for selected simulants, IP Commitment 5.2.3.2 (Target Completion Date 15 days in advance of conducting tests).
5. (IN PROGRESS) LSIT includes testing to demonstrate solids remobilization and sufficient bottom motion to release gas (applicable to both abnormal and accident conditions). Testing will be performed on non-Newtonian and Newtonian platforms.
   - Develop Test Plan, IP Commitment 5.1.3.6 (Target Completion Date 15 days prior to conducting test).
   - Analysis of Test Results, IP Commitment 5.1.3.7 (Target Completion Date nine months after completion of test series).

Actions to Resolve 1.a:

6. (COMPLETE) Mixing to prevent accumulation of gasses in non-Newtonian vessels was determined to be safety. In design, safety mixing translates to safety air supply to PJMs and spargers that are backed up by another air supply (redundancy is a result of applying single failure criteria to the severity level and hydrogen gas generation rate).
   - *Preliminary Documented Safety Analysis - Control Strategy Changes for the PT Facility* (24590-WTP-PSARA-ENS-09-0001, Rev. 6).
   - *Integrated Safety Management*, Table F1 (24590-WTP-GPG-SANA-002, Rev. 12A).
7. (IN PROGRESS) LSIT includes plans for testing to develop a scaling basis in order to apply mixing analyses to full scale vessels (with a sufficient design margin).
   - Scaling Basis, IP Commitment 5.1.3.13 (Target Completion Date April 30, 2012).
8. (IN PROGRESS) LSIT includes plans for testing to verify CFD analysis software. Then the verified CFD software can be applied to all vessels (with a sufficient design margin).
   - Complete V&V of CFD, IP Commitment 5.3.3.7 (Target Completion Date October 31, 2012).
   - CFD analysis of planned LSIT, IP Commitment 5.3.3.11 (Target Completion Date August 31, 2013).
   - CFD prediction of LSIT performance assessment, IP Commitment 5.3.3.12 (Target Completion Date eight months after completion of reports on selected comparison tests).

Actions to Resolve 1.b:

9. (IN PROGRESS) It is expected that LSIT simulant selection and the conduct of testing will adequately replicate the settled layer characteristics and settling dynamics to address this concern.
   - See Actions 4 and 5 on page A-19.

Issue Closure:

Following completion of the listed actions: process waste simulant bases will be established for testing based on meeting requirements to demonstrate mixing is sufficient to release gas from the range of process wastes; the PJM mixing calculations to demonstrate the vessels meet their vessel specific mixing requirements; and performance testing results will be reviewed to verify adequacy in addressing the recommendation.

Attachment B – Additional Concerns (not related to the *Implementation Plan for DNFSB Recommendation 2010-2*)

Solids Transport and Pumping Concern 1 *To the best of our knowledge, results of the M-1 Pipe line plugging studies (WTP-RPT-175 Deposition Velocities of Newtonian and Non-Newtonian Slurries in Pipelines, WTP-RPT-178 A Qualitative Investigation of Deposition Velocities of a Non-Newtonian Slurry in Complex Pipeline Geometries, WTP-RPT-189, Deposition Velocities of Non-Newtonian Slurries in Pipelines: Complex Simulant Testing) have not been incorporated into the WTP plant design guide. Given the Hanford Tank Wastes and the WTP plant processes, the design guide must be robust enough to consider both the Newtonian and Non-Newtonian material transport challenges. Also the 30% factor in the design guide is not an engineering margin but a factor to cover the data scatter related to the correlation so the inclusion on additional margins would be needed to be conservative.*
Solids Transport and Pumping Concern 1.a *PNNL is unaware of a design guide (as of February 2010) for pumping of Non-Newtonian materials. Use of the Newtonian design guide will under predict critical suspension velocities for slurries carrying dense particles.*
Solids Transport and Pumping Concern 1.b *The stability map developed in WTP-RPT-175, identified the three boundary conditions (Laminar, Transitional, and Turbulent Critical) that must be evaluated for each transport pipe to assure transport of the wastes do not result in partial or total (plugging) deposition. We do not believe the three part evaluation has been added to the design guide. Depending on the planned pumping mode, pipelines from vessels FRP-02A, FEP-17A/B, Process drains for HLP-22 and FRP systems, HLP-22 transfer pump 21, and the transfer pump 17 for HLP-27 and HLP-28 all have actual velocities of below 4 feet per second as of the February 2010 design. The results documented in WTP-RPT-175 highlight the need to reevaluate these and other lines looking at all three boundary conditions. Given the nature of the materials being transported, the analyses are important to reduce the risk of pipe plugging.*

Status:

Accepted, closed.

Background:

Evaluation of issued line plugging reports has been documented, and multiple design guides for slurry transport are used at WTP. As stated in CCN 137169, *Use of M1 Mixing Test Data Provided by Pacific Northwest National Laboratory (PNNL)*, only the test data in *Deposition Velocities of Newtonian and Non-Newtonian Slurries in Pipelines* (WTP-RPT-175) is accepted for use on the WTP Project. Guidelines are set with regard to expected Reynolds number for WTP transfer lines. WTP design guides advise the system engineer to consult the subject matter expert (SME) from Bechtel's Geotechnical and Hydraulic Engineering Services where the flow does not meet the required Reynolds number or for any other slurry transport conditions outside the design guide criteria.

Actions to Resolve:

1. (COMPLETE) WTP-RPT-175 has been evaluated for use at the WTP, and guidance has been provided for acceptable use of the test data.
   - *Use of M1 Mixing Test Data Provided by Pacific Northwest National Laboratory (PNNL)* (CCN 137169).
2. (COMPLETE) Multiple design guides for flow of Newtonian and non-Newtonian fluids to aid in slurry piping design have been developed from literature on standard calculation methods and issued for use at the WTP.
   - 24590-WTP-GPG-M-0058 – *Minimum Flow Velocity for Slurry Lines* provides guidance to engineers for predicting critical velocity for WTP design.
   - 24590-WTP-GPG-M-016 – *Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model* is applicable to Bingham plastic fluids in laminar and turbulent flow conditions. This design guide provides the method to determine if the guide is appropriate to use based on the slurry properties, the pressure drop per length of pipe, and the pressure drop for valves and fittings.
   - 24590-WTP-GPG-M-039 – *Determination of Pressure Drop for Lines with Liquids Containing Solids – Power Law Fluids* is applicable to Power Law fluids in laminar and turbulent flow conditions. This design guide provides the method to determine if the guide is appropriate to use based on the slurry properties, pressure drop per length of pipe, pressure drop for valves and fittings, and total pressure drop for a given system transferring a Power Law fluid.
3. (COMPLETE) The references and evidence supporting the 30% margin applied to slurry piping designs have been documented.
   - *Minimum Flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A) selects and documents justification for the design margin.
   - A design margin of 30% is general design practice for turbulent slurry flow as indicated in *Cameron Hydraulic Data*, 19th Edition, Flowserve (2002).
4. (COMPLETE) Provide additional guidance on slurry transport design margins for pipeline flushing to account for uncertainties in the waste stream properties.
   - *Supplemental Guidance for Application of Design Margin to Slurry Transport Design* (CCN 156101).
5. (COMPLETE) The results of the *Minimum flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A) methodology (i.e. predicted slurry critical velocity) have been compared with empirical data.
   - Results show the critical velocity calculation methods from 24590-WTP-GPG-M-0058 predict or over predict and bound non-Newtonian fluids even though the guide is intended for Newtonian fluids (*Preliminary EFRT M1 Reference Case Testing Results* – CCN 177635).

Actions to Resolve 1.a and 1.b:

6. (COMPLETE) Two design guides are available for Non-Newtonian materials and advise that laboratory analysis of waste properties must be used to determine applicability of the appropriate slurry design guide.
   - *Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model* (24590-WTP-GPG-M-016, Rev. 2).
   - *Determination of Pressure Drop for Lines with Liquids Containing Solids – Power Law Fluids* (24590-WTP-GPG-M-039, Rev. 2).
7. (COMPLETE) *Minimum flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A) has been clarified for its intended use with Newtonian fluids, not with non-Newtonian fluids, and for flow with recommended Reynolds number of 40,000 or greater (can also be used to size line for liquid flush of a non-Newtonian line).
   - Procedure/Guide Change Notice for *Minimum flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A).
   - *Minimum flow Velocity for Slurry Lines* (24590-WTP-GPG-M-0058, Rev. 0A) advises the system engineer to consult the SME in cases where the flow does not meet the required Reynolds number.
8. (COMPLETE) The critical velocity and Reynolds number were calculated for all pre-existing slurry transfer lines to determine if the design guide requirements are met.
   - The analytical review of all slurry pipelines proposed design changes to pumps and piping which are documented in *Implementation of External Flowsheet Review Team (EFRT) Recommendations - M1, Evaluation of Mechanical Plugging in Process Piping* (24590-WTP-RPT-PR-07-001, Rev. 0).
9. (COMPLETE) The results of the slurry pipeline analytical review (i.e. M1 closure recommendations) were considered during revision of pump and piping design calculations.
   - In order to meet NPSHa, process flow rate, pump discharge pressure, and critical velocity requirements, engineering calculations determined that some changes proposed in EFRT issue M1 closure required modification when implemented into the WTP design.

Issue Closure:

All listed actions are complete.

Plant Process Concern 1 *Post Filtration Precipitation – WTP has proposed a revised flow sheet to deal with the potential for post filtration precipitation. This new flow sheet relies upon a complicated control scheme to maintain the solutions below the solubility limit. In addition, temperature control at elevated temperatures (the objective is to increase the solubility) is a significant part of this control scheme. This control scheme has not been demonstrated and was not part of the pilot scale PEP demonstration. There is a significant risk that this control scheme won't work or will be too complicated to allow a reasonable production rate.*
Plant Process Concern 2 *Ion Exchange Operating Temperature – As part of the above temperature control, the WTP has increased the cesium ion exchange temperature from 25 C to 45 C. Testing at ORNL has suggested that the resin may not have sufficient stability at 45 C. Testing is currently planned at PNNL to assess this impact, however there is a significant chance that these test results will challenge the design basis for the ion exchange system.*
Plant Process Concern 4 *Precipitation in Permeate (i.e. filtrate) Streams from Ultrafilters - Many permeates have been found to precipitate solids following the ultrafiltration process (WTP-RPT-197 and WTP-RPT-200 Rev 1, PEP Support: Laboratory Scale Leaching and Permeate Stability Tests). The solids are mainly (but not limited to) sodium oxalate and sodium phosphate. These precipitates cannot be sent forward in the process to ion exchange since the ion exchange columns will plug. The precipitates are either recycled back to the head end of the pretreatment process or dissolved with additional water. In either case the efficiency of the pretreatment process is impacted.*

Status:
Accepted, open.

Background:
Alternative design approaches to address post-filtration precipitation have been evaluated and the DOE selected design change titled "Equipment Option" has been implemented (evaluation shown in 24590-WTP-RPT-PET-09-004 and DOE direction shown in CCN 216051). The feasibility of processing waste through CXP at an elevated temperature was given a preliminary evaluation using existing SRNL test data at 45 °C (e.g., batch contact, kinetics) (*Batch, Kinetics, and Column Data from Spherical Resorcinol-Formaldehyde Resin* – SCT-M0SRLE60-00-110-00029, Rev. B). The new design has been evaluated in the G2 model for impacts to throughput.

Actions to Resolve:

1. (COMPLETE) WTP has issued a waste pre-qualification plan for determining the appropriate processing of waste that may cause post filtration precipitation, addressing uncertainty in waste characteristics, and estimating the performance of the WTP unit operations. (Note that this action is closed since the purpose is to explain that waste is pre-qualified to estimate performance of process operations.)
   - Operator intervention will be guided by the pre-qualification testing (*Plan for WTP Feed Pre-Qualification* – 24590-WTP-PL-OP-07-0001, Rev. 1).
   - Process control samples will also offer guidance for operator intervention (*Integrated Sampling and Analysis Requirements Document (ISARD)* – 24590-WTP-PL-PR-04-0001, Rev. 2).

- Waste pre-qualification analysis will occur 6 months before transfer of waste feed to WTP (*ICD 19 - Interface Control Document for Waste Feed* – 24590-WTP-ICD-MG-09-019, Rev. 5).

2. (COMPLETE) P&IDs for the Cesium Ion Exchange Process System (CXP) and Ultrafiltration Process System (UFP) have been recommitted with basic control logic shown for the design change to mitigate post-filtration precipitation.
   - CXP system and UFP system P&IDs have been revised to incorporate the equipment option.
3. (COMPLETE) Controls & Instrumentation (C&I) engineers are closely involved in the P&ID revision process, and C&I is a required signature on all P&ID revisions.
   - *Review of Engineering Documents* (24590-WTP-3DP-G04T-00913, Rev. 10A).
   - *P&ID Development* (24590-WTP-GPG-M-030, Rev. 9A).
4. (COMPLETE) A schematic has been included in the CXP System Description depicting the overall CXP controls design and integration with UFP-VSL-00062A/B/C resulting from the Equipment Option design change.
   - See Figure 7-1 in *System Description for the Cesium Ion Exchange Process (CXP System* (24590-PTF-3YD-CXP-00001, Rev. 2).

Actions to Resolve 1:

5. (IN PROGRESS) Develop detailed controls for CXP/UFP and issue control logic diagrams and enhanced DCNs. Addition of reagents to UFP-VSL-00062A/B/C will be an operator initiated action and will be determined in waste pre-qualification testing. Reagents addition and monitoring IX column operating modes are the primary features requiring operator interaction. Design features that do not require operator interaction include temperature monitoring and minimizing concentration swings of ion exchange feed (accomplished by having a large recirculating waste volume and by recycling the very low concentration washes from UFP to PWD.)
   - Completion of control logics/DCNs for CXP and UFP are scheduled activities.
6. (IN PROGRESS) Document a formal hazards analysis for the CXP and UFP systems.
   - *Hazards Analysis Report for the WTP Pretreatment Facility* (24590-PTF-HAR-ENG-11-0002, Rev. 1)
   - CXP formal hazards analysis is underway and in the process of reviewing insight records.
   - UFP formal hazards analysis is complete and accident analysis and control selection will follow.

Actions to Resolve 2:

7. (COMPLETE) A preliminary review was completed that did not find any "show stoppers" using existing data for stability of Resorcinol Formaldehyde resin, and capability to use the resin in 45°C operations was identified as an assumption.
   - *Recommendation of Alternative to Mitigate Solids Precipitation in Ion Exchange Feed* (24590-WTP-RPT-PET-09-004, Rev.1).

8. (IN PROGRESS) Perform additional testing to provide thorough data of ion exchange resin performance at the design conditions set in the Equipment Option (ie. providing data for extended processing at elevated temperatures).
   - PNNL subcontract under 24590-QL-HC9-WA49-00001-WA35, Service Requisition 24590-QL-SRA-W000-00144.

Actions to Resolve 4:

9. (COMPLETE) The design changes to resolve the post-filtration precipitation issue as well as design changes to resolve other outstanding issues were included in recent G2 model runs. The results indicate that the WTP capacity to process Hanford waste increased as a result of the design changes while producing fewer IHLW canisters and ILAW canisters. Most precipitates remain in solution in the new design and are processed in LAW Vitrification.
   - *WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. A).

Issue Closure:

Following completion of the listed actions: the enhanced control logic DCNs; CXP and UFP hazard controls selection reports; and ion exchange resin test report will be reviewed to verify adequacy in addressing the recommendation.

Plant Process Concern 3 *Leaching Performance – Due to vessel corrosion concerns, the leaching temperature is limited to 85 C for the caustic leaching process. At this temperature, the leaching of the Al in the mineral phase of boehmite will be significantly limited. Boehmite leaching has relatively large activation energy (~ 120 kJ/mole) and as such is very temperature sensitive. Limiting the temperature to 85 C will significantly limit the quantity of boehmite that can be leached. This is compounded by the recent changes for post filtration control which aim to limit the quantity of caustic used. This limitation in caustic will also significantly impact the quantity of boehmite that can be leached. Taken together, these two changes may severely limit the leaching of boehmite – which represents up to 50% of the leachable aluminum in the tank farms. This will result in a significant increase in the number of HLW canisters produced with the resulting increase in plant operating time.*

Status:

Accepted, open.

Background:

Caustic leaching performance has been evaluated; impacts to the number of HLW canisters has been reviewed and meets throughput requirements. A thorough analysis of caustic leaching has been completed, and an analysis of waste loading in HLW glass indicates Boehmite is not an overwhelming process driver. A series of figures from the analysis documented in the *WTP Tank Utilization Assessment* is provided below. Waste pre-qualification testing is used to identify challenging process wastes and determine the most efficient processing strategy.

Actions to Resolve:

1. (COMPLETE) All feeds will be analyzed according to the Waste Pre-Qualification Plan and used to determine the most efficient leaching conditions while preventing vessel corrosion. (Note that this action is closed since the purpose is to explain that waste is pre-qualified to estimate performance of process operations.)
   - *Plan for WTP Feed Pre-Qualification* (24590-WTP-PL-OP-07-0007, Rev. 1).
   - Black cell vessels are designed to last the life of the facility *Basis of Design* (24590-WTP-DB-ENG-01-001, Rev. 1Q).
2. Material of construction is specified on vessel datasheets based on corrosion evaluations.
   - *24590-PTF-MV-UFP-VSL-00001A – Ultrafiltration Feed Preparation Vessel* (24590-PTF-MVD-UFP-00001, Rev. 12).
   - *24590-PTF-MV-UFP-VSL-00001B – Ultrafiltration Feed Preparation Vessel* (24590-PTF-MVD-UFP-00002, Rev. 12).
   - *24590-PTF-MV-UFP-VSL-00002A – Ultrafiltration Feed Vessel* (24590-PTF-MVD-UFP-00014, Rev. 11).
   - *24590-PTF-MV-UFP-VSL-00002A – Ultrafiltration Feed Vessel* (24590-PTF-MVD-UFP-00015, Rev. 11).
3. (COMPLETE) Testing indicates the boehmite in Hanford waste has a lower activation energy. An activation energy of 60 kJ/mole is used in the process model based on testing. (The approximate range from testing is 40 – 60 kJ/mole).
   - *Characterization and Leach Testing For Redox Sludge and S-Saltcake Actual Waste Sample Composites* (24590-QL-HC9-WA49-00001-03-00010, Rev. A).
4. (COMPLETE) To estimate the amount of boehmite in the waste aluminum, the following figures are used in the G2 model:
   - The amount of aluminum in the expected waste feeds is shown in Figure 1 on page 8.
   - The breakdown of aluminum constituents in the expected waste feeds is depicted in Figure 2 on page 9.
   - *WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. A).
5. (COMPLETE) To approximate the time required for caustic leaching at 85°C, the following figures are used in the G2 model:
   - Each small circle on Figure 3 on page 9 is a Vessel UFP-2A batch. Several small circles clustered together appear as a line in the figure. The left axis is the leach time performed for the batch. Batches requiring just gibbsite leaching or no leaching are shown at or below the 4-hour line. Batches requiring boehmite leaching are shown above the 4-hour line. Batches between the 4-hour and 16-hour lines were successfully leached to produce the minimum HLW glass mass. Batches residing on the 16-hour line did not have sufficient leach time to produce the minimum HLW glass mass.
   - Figure 4 on page 10 shows the amount of aluminum leached for each batch of waste.
   - *WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. A).

6. (COMPLETE) An assessment of the HLW glass constituents is documented based on G2 model results which demonstrates the Al_2O_3 is not the limiting constituent in terms of HLW glass composition restrictions for most feeds.
    - Figure 5 on page 10 provides the waste loading in HLW glass (in green) and the limiting waste constituent in each load (in red).
    - *WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. A).
7. (IN PROGRESS) Develop leaching process steps and obtain DOE approval (ie. obtain approval of Specification 12).
    - Proposed Process Steps for Sludge Treatment, Contract Deliverable Item No. 2.10 in Table C.5-1.1 in *WTP Contract*, DE-AC27-01RV14136 (Completion date is one year before start of cold commissioning for the PTF).
    - Procedure to Determine the Waste Feed Treatment Approach, Contract Deliverable Item No. C.7-1 in Table C.5-1.1 in *WTP Contract*, DE-AC27-01RV14136 (Completion date is one year before start of cold commissioning for the PTF).

Issue Closure:
Following completion of the listed action: the contract deliverables will be reviewed to verify adequacy in addressing the recommendation.

Figure 1 Aluminum Mass per TFCOUP 6 Batch (Figure 4.1-1 of *2008 WTP Tank Utilization Assessment*)

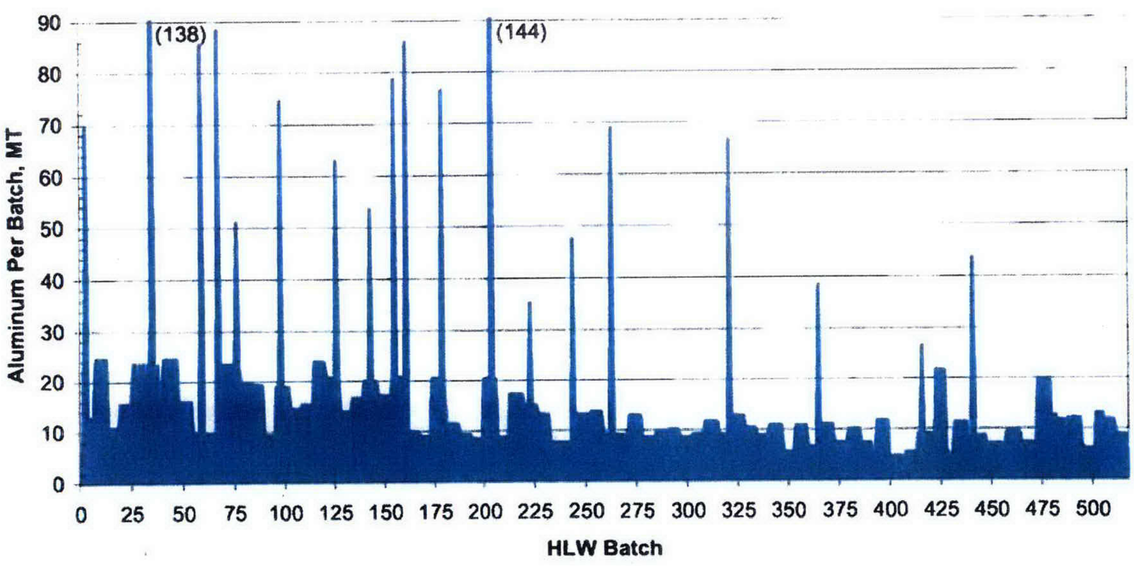


Figure 2 Partitioning of Aluminum per TFCOUP 6 Batch (Figure 4.1-3 of *2008 WTP Tank Utilization Assessment*)

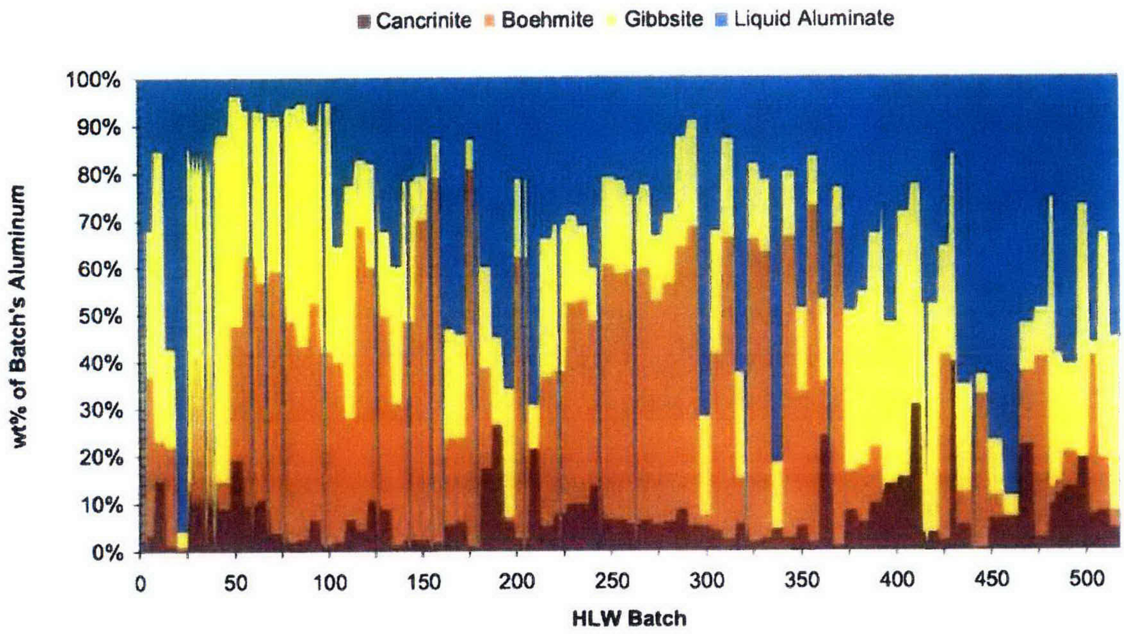


Figure 3 Caustic Leach Time in UFP-2A Batches (Case 2 - Boehmite) (Figure 3.1-1 of *2010 WTP Tank Utilization Assessment*)

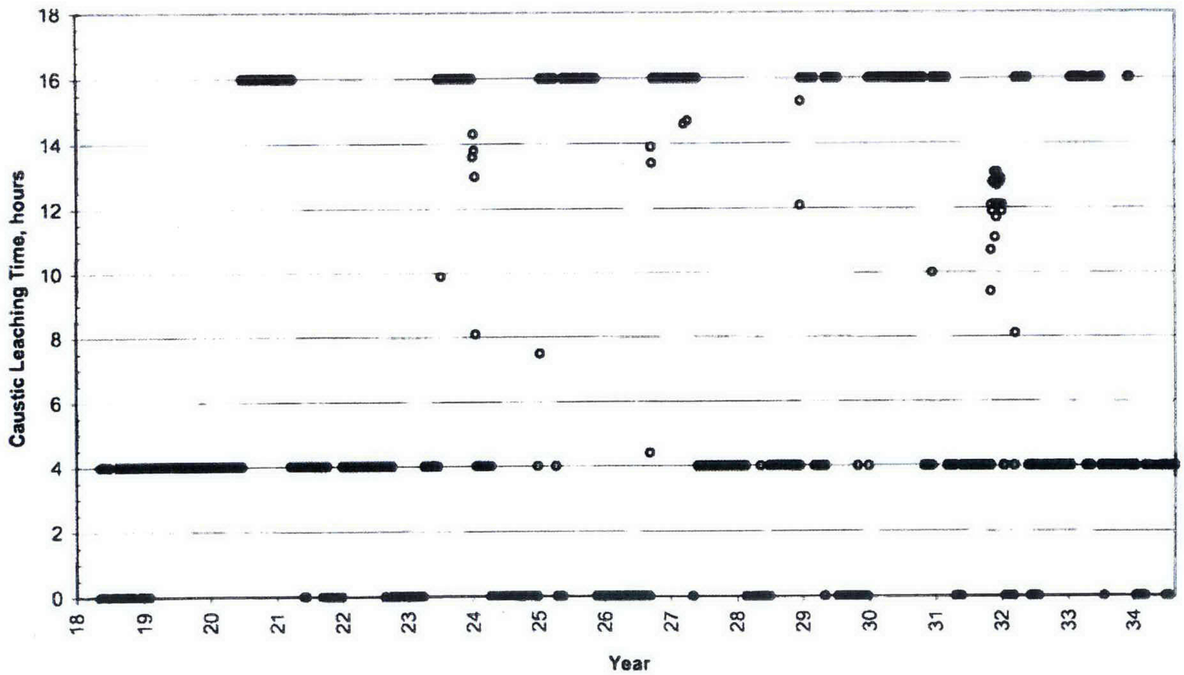


Figure 4 Aluminum Leached (Case 2) (Figure 3.2-6 from *2010 WTP Tank Utilization Assessment*)

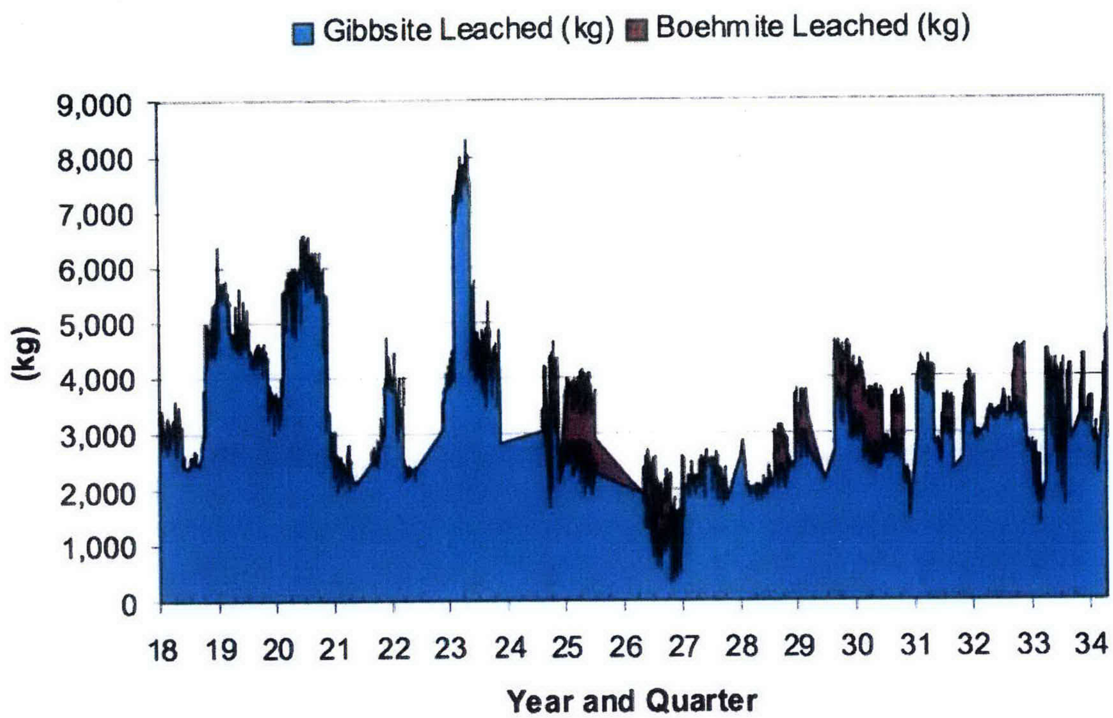
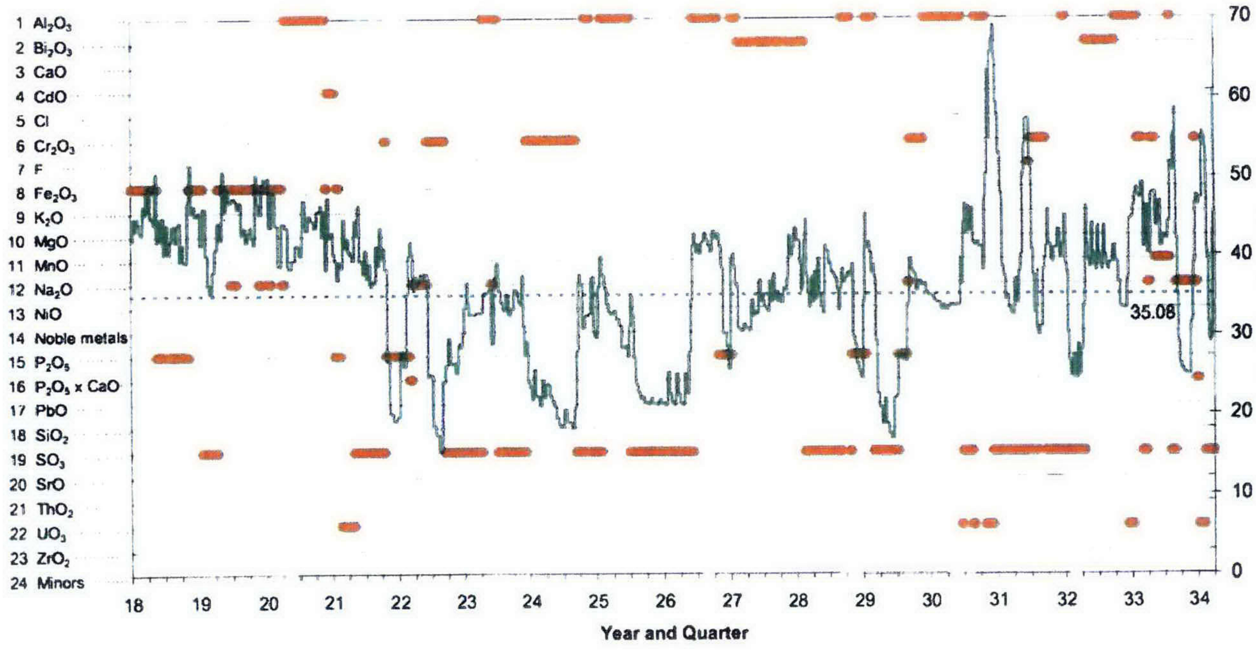


Figure 5 HLW Glass Limiter and Waste Loading (Case 2 - Boehmite) (Figure 3.4-4 of *2010 WTP Tank Utilization Assessment*)



Plant Process Concern 6 *Process Stream Recycle - The WTP process involves a significant number of recycle streams that have the potential to recycle problem components. Known problem components include: Technetium (Tc), oxalate and glass forming chemicals. These components may buildup in the recycle streams causing various process difficulties.*

Plant Process Concern 6.a *Some of the Tc is volatilized in the melters (both LAW and HLW) into the melter off-gas systems. The off-gas streams are scrubbed to remove the Tc (and other components) which is recycled back to the pretreatment facility. Since both melters volatilize the Tc, the Tc will buildup in the process system. Glass forming chemicals that are recycled may form insoluble sodium alumino silicates in the evaporators in the pretreatment facility. This is an issue that has occurred at SRS as part of the DWPF processing. Sodium oxalate is sparingly soluble and precipitates in the filtrates from the ultrafiltration process. If the precipitates are not dissolved with excess water they are recycled back to the head end of the pretreatment process.*

Status:

Accepted, open.

Background:

Sodium-alumino-silicate (NAS) solids are expected to form due to recycles from the glass plants, but they are not expected to plate out on the internals of the evaporators the way they were observed to do at Savannah River Site (SRS) due to differences in design. Implementation of the Equipment Option design change to address post-filtration precipitation has resolved the recycle issues as demonstrated by the Dynamic G2 process model. The G2 process model provides an assessment of particular waste constituents that have previously been identified as building up in the process streams. In particular, the estimated mass balance for technetium is provided in Figure 6 on page 13. Additionally, testing is planned to evaluate the potential for precipitation for the treated LAW concentrate in the transfer between PTF and LAW.

Actions to Resolve 6 and 6.a:

1. (COMPLETE) Engineering studies on the recycling and precipitation technical issues have been documented. One of the proposed options, called "Equipment Option" was selected to resolve the issues.
   - *Assessment of Solids Formation and Recovery for Pretreatment Vessels CNP-VSL-00003, CNP-VSL-00004, CXP-VSL-00004, and UFP-VSL-00062A/B/C* (24590-WTP-RPT-PET-10-017, Rev. 0).
2. (COMPLETE) The Dynamic G2 process model previously identified the buildup of Sodium Oxalate, Phosphorous, and Aluminum caused by recycling of wash and leach streams in the Pretreatment Facility. With implementation of the Equipment Option, the amount of Aluminum, Phosphorous, and Sodium Oxalate being recycled in Pretreatment are reduced.
   - *2010 WTP Tank Utilization Assessment* (24590-WTP-RPT-PET-10-020, Rev. 0).

3. (COMPLETE) Comparison of the Hanford and SRS evaporator designs shows SRS 242-H evaporator runs at atmospheric pressure, where the boiling point is ~120 °C. The 242-A and 242-S evaporators at Hanford run at about 40-80 torr absolute pressure, where the boiling point is typically in the range of 40-50°C. The 242-A and 242-S evaporators have not experienced any difficulties with NAS build-up, though the wastes do contain significant amounts of NAS.
   - The WTP evaporators all have similar designs (vacuum operation) to the 242-A and 242-S evaporators.
4. (COMPLETE) Tc-99 in the recycle stream does not continually accumulate but reaches some steady-state concentration according to melter testing using rhenium as a surrogate for technetium.
   - *DuraMelter 100 Tests to Support LAW Glass Formulation Correlation Development* (24590-101-TSA-W000-0009-169-00001, Rev. A).
5. (COMPLETE) G2 model runs show the plant can manage the steady state Tc-99 concentration based on an assessment of the WTP technetium mass balance. Currently, Supplemental LAW Treatment plans to treat their own effluents, and the G2 model shows Tc-99 recycle is only an issue if Supplemental LAW were to transfer Tc-99 containing effluents back to WTP.
   - *2010 WTP Tank Utilization Assessment,* 24590-WTP-RPT-PET-10-020, Rev. 0.
   - Figure 6 on page 13 is the estimated technetium mass balance from the 2010 Tank Utilization Assessment.
6. (IN PROGRESS) A study is in progress at Tank Farms concerning Tc-99 in WTP.
   - Results of the Tc-99 study will be evaluated for impacts to the WTP process flow sheet.
7. (IN PROGRESS) There is testing and evaluation planned as a result of the process operating limits gas assessments completed per External Flowsheet Review Team (EFRT) issues M6 (Process Operating Limits Not Completely Defined) and P4 (Potential Ultrafiltration/Leaching Issue - Gelation & Precipitation)..
   - Testing is planned to evaluate the potential for Precipitation at Operating Limits for LAW Concentrate from PTF to LAW per Scoping Statement M6-1 and Section 3.3 of 24590-WTP-PL-RT-07-0002, Rev 0. The tests for this item are being developed to include constituents known to form gels, precipitates that could plate on cool surfaces or higher than expected levels of precipitate that could impact the transfer between PTF and LAW. Since temperatures are maintained in PTF vessels to mitigate potential precipitation, this work focuses on the transfer to LAW.

Issue Closure:

Following completion of the listed action: testing results to evaluate potential for unexpected precipitation in treated LAW concentrate from PTF to LAW will be reviewed to verify adequacy in addressing the recommendation.

Figure 6 Tc-99 Mass Balance