

**Integrated Waste Feed Qualification Program for Direct LAW Feed to WTP
– 16421**

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ABSTRACT

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is a one-of-a-kind facility being designed and constructed for DOE by Bechtel National, Inc. (BNI) and principal subcontractor URS, to process and vitrify radioactive waste stored in underground tanks at the Hanford Site. The Tank Operations Contractor (TOC), Washington River Protection Solutions (WRPS), has the responsibility to retrieve, stage, pretreat, and deliver feed directly to the WTP Low Activity Waste (LAW) Vitrification Facility. The Direct Feed LAW (DFLAW) scenario is being considered by DOE as a strategy to treat Hanford tank wastes as soon as practicable. Extensive planning is underway by One System, an effort with joint participation by WTP and TOC personnel. The initial focus of One System is to achieve the required integration to ensure the waste feed meets acceptance requirements for processing in the TOC Low Activity Waste Pretreatment System (LAWPS) and WTP LAW facilities.

The integrated waste feed qualification program approach for DFLAW was defined by One System during a four-day workshop. The effort resulted in a feasible approach for integrating LAWPS and LAW feed acceptance requirements to vitrify low-activity waste while complying with facility design basis, safety basis, waste acceptance criteria, and glass product compliance. The defined qualification program will provide a systematic approach to test newly staged feed campaigns at bench-scale using actual tank waste samples. The required integration and basis for obtaining sufficient and necessary data to qualify the feed for DFLAW facilities are discussed in this paper.

INTRODUCTION

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) facilities are being constructed to process and vitrify radioactive hazardous waste that is currently stored at the Hanford Site in underground tanks. The stored waste comprises highly radioactive solids and liquid fractions in the form of sludge, saltcake, and supernatant liquid. The WTP facilities under construction by Bechtel National Inc. (BNI), include Pretreatment (PT) Facility for pretreating and separating the waste into low-activity waste (LAW) supernatant feed and high-level waste (HLW) sludge feed fractions. Each separated feed fraction will then be transferred to the corresponding LAW or HLW vitrification facility for combining with glass formers to form the immobilized low-activity waste and immobilized high-level waste glass products. In addition to the PT, HLW, and LAW facilities, other facilities in WTP include the Analytical Laboratory (Lab) for process analytical support and the Balance of Facilities (BOF) for plant maintenance, support, and utility services.

The Direct Feed LAW (DFLAW) scenario is being considered by DOE as a strategy to treat Hanford tank wastes as soon as practicable. The near-term emphasis is on completing the LAW facility to enable acceptance of waste directly from the tank farms for vitrification, bypassing the PT Facility until it is completed. This emphasis includes completion of the Lab and BOF to provide the needed support and infrastructure for DFLAW process operations. Also, the Effluent Management Facility (EMF) within LAW facility is being designed to allow for recycling/blending of concentrated effluent back into the LAW waste stream. The EMF will maintain the ability to transfer the effluent stream to the Hanford site for subsequent treatment or discharge to the tank farm double shell tank (DST) system.

The tank waste supernatant will be staged by Tank Operations Contractor (TOC) as LAW feed campaigns. TOC will pretreat the staged feed in the TOC Low Activity Waste Pretreatment System (LAWPS) prior to transfer to receipt vessels in the LAW Facility.

As part of One System, several activities have been initiated with joint participation by WTP Contractor and TOC personnel to develop a program to integrate and align the waste feed acceptance and qualification requirements for processing in the LAWPS and LAW facilities.

CURRENT PRACTICES

Hanford Best Basis Inventory (BBI) information is used as input to the Hanford Tank Waste Operations Simulator (HTWOS) to identify the optimal waste blending and staging scenario. This information serves as the basis for the Integrated Waste

Feed Delivery Plan (IWFDP), which describes the appropriate sequencing of the waste through multiple tank farm facilities and infrastructure for feed transfer into the staged DSTs. The DOE Office of River Protection (ORP) approves the IWFDP and other programmatic plans to provide the authorization necessary for TOC and the WTP contractor to proceed with preparing for waste transfer and treatment operations. This includes the ORP approval of each individual batch. Tank waste characteristics and inventory are maintained in the BBI database, which is updated with the most current waste characterization information. Samples from tank waste are collected and routinely shipped to the Hanford site laboratory for characterization and waste transfer analyses in support of process control, regulatory/permit requirements, and tank closure.

The LAW treatment and vitrification process planning and operations involve numerous contractors, organizations, and facilities. As a result there can be, a) different contractual requirements; b) multiple laboratories; c) multiple sample handling/packaging/shipping; d) potentially longer turnaround time for sample results; e) inadequately defined or conflicting requirements; f) different interpretation of qualification requirements; g) potentially redundant or excessive paperwork; and h) required approvals at inappropriate levels. A need for an effective feed qualification program integrated across all involved contractors, organizations and facilities was recognized to streamline the requirements and eliminate redundancies.

QUALIFICATION PROGRAM DEVELOPMENT APPROACH

Successful implementation of the integrated DFLAW feed qualification program would require changing some paradigms related to current Hanford and WTP planning documents as well as evaluating the applicability of existing processes used to qualify high-level waste glass produced in the Defense Waste Processing Facility at the Savannah River Site.

WRPS has introduced the Lean management system in a renewed effort to reduce waste and non-value added work, simplify and streamline processes in the tank farms, and improve performance. Lean management is a system of continuous improvement that can be applied to any work process. The system allows evaluation of work practices to identify and remove inefficiencies for improving the work process.

One System used the Lean management system to address development of an integrated feed qualification program. Specifically, the preferred path for feed qualification was defined during a Lean management rapid improvement event (RIE) in April 2015. RIEs are typically week-long activities in which a team of

experts is assembled to specifically focus on areas for improvement. The feed qualification RIE was held to exchange knowledge on facility design, equipment and planned process operations within LAWPS and LAW facilities.

Key feed qualification elements considered during the RIE were related to:

- **Feed Staging** – Flowsheet planning, development of the IWFDP schedule, and DST transfer activities to provide appropriate waste feed.
- **Feed Acceptance and Qualification** – Sampling, analyses, and select unit operation testing of the staged feed campaign at bench-scale. Necessary data and documentation are collected in accordance with established data quality objectives (DQOs). This includes collecting data necessary to demonstrate compliance with facility operations and regulatory permits for processing the staged feed campaigns. Evaluation of laboratory results that demonstrate the LAWPS and LAW waste acceptance criteria (WAC) and feed processability are met to qualify the feed campaign for pretreating and vitrifying into immobilized LAW glass.
- **Data Requirements** – Define data flow to establish baseline feed characteristics, and optimize the campaign specific operating parameters for processing the staged feed through LAWPS and LAW facilities. Identify process monitoring parameters including in-line instruments and/or confirmatory samples to ensure processes are in compliance with facility design basis, safety basis, and glass product compliance. Provide estimates for secondary effluents and waste generation to assist in managing the Effluent Management Facility (EMF) recycle streams and generated waste.

FEED STAGING

Key success elements for feed staging are to continuously update the BBI with the best available waste characterization data and to update process flowsheets to match information gained from process testing and maturation activities. To ensure the tank farms systems are ready to transfer feed when necessary, the IWFDP describes the appropriate sequencing of the multiple tank farm facility and infrastructure projects necessary to transfer feed into the staged DSTs. A key paradigm shift required to implement this associated activity of the qualification program is to move the ORP approval from individual feed batches to approving the entire feed program as described in the IWFDP for transferring the feed to the LAW facility. Two DSTs will be dedicated to DFLAW feed qualification so one can be qualified while the other is being filled in preparation for the following campaign.

FEED ACCEPTANCE AND QUALIFICATION

Sampling, analyses, and processability testing for qualifying the waste feed are initiated when approximately a million gallon feed campaign is staged in the DST. The plan is to focus on one sampling event to obtain sufficient and necessary data for qualifying the staged LAW feed through waste acceptance and processability in LAWPS and LAW facilities. The need for an integrated DFLAW feed qualification program and DQO process was identified in the DOE-River Protection Project (RPP) Integrated Flowsheet Maturation Plan [1]. The sample and data collection requirements for feed qualification is provided in Figure 1 to show the flowdown and traceability of the staged DST campaign samples.

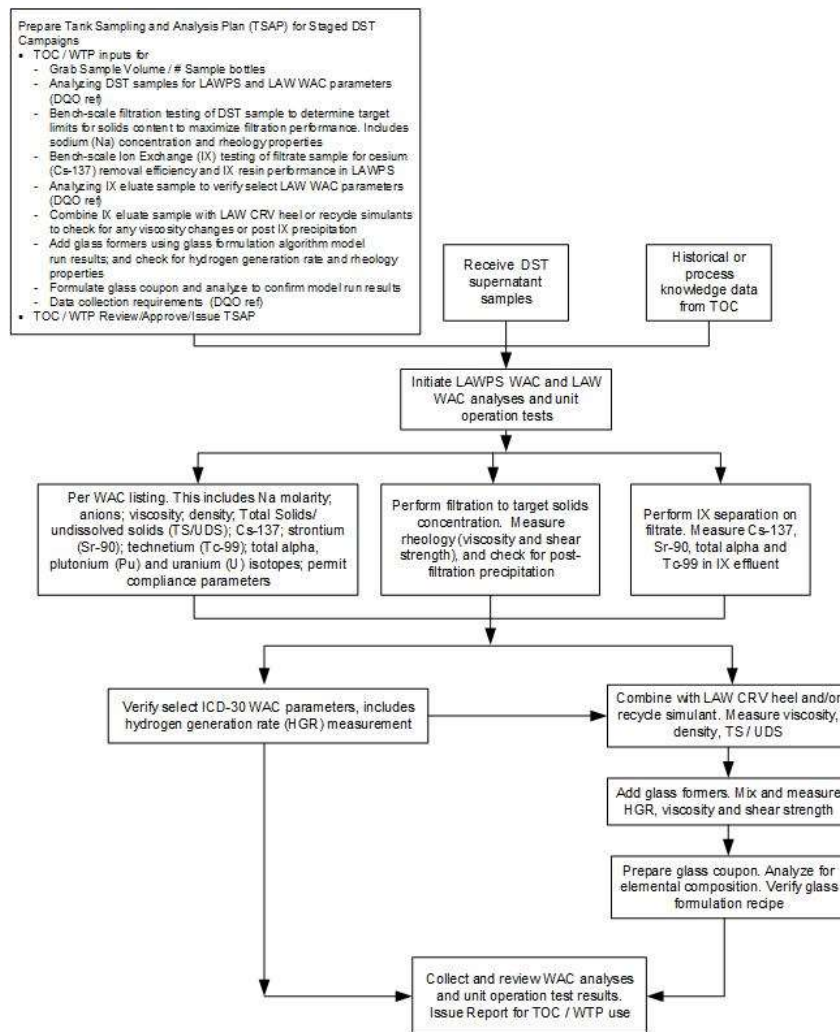


Figure 1: DFLAW Qualification Sampling and Analyses

It should be noted that waste acceptance criteria analyses and process testing analyses are part of feed qualification because both types of data are required to support the decision to accept and process the feed through systems yet to be commissioned. While initial startup activities will likely require additional downstream sampling for confirmation or verification until the actual process performance characteristics are well known, it is the long term goal to have enough confidence in the qualification of staged DST feed for minimizing sample collection and analyses. The planned process description and sample flow path for DFLAW operation are shown in Figure 2.

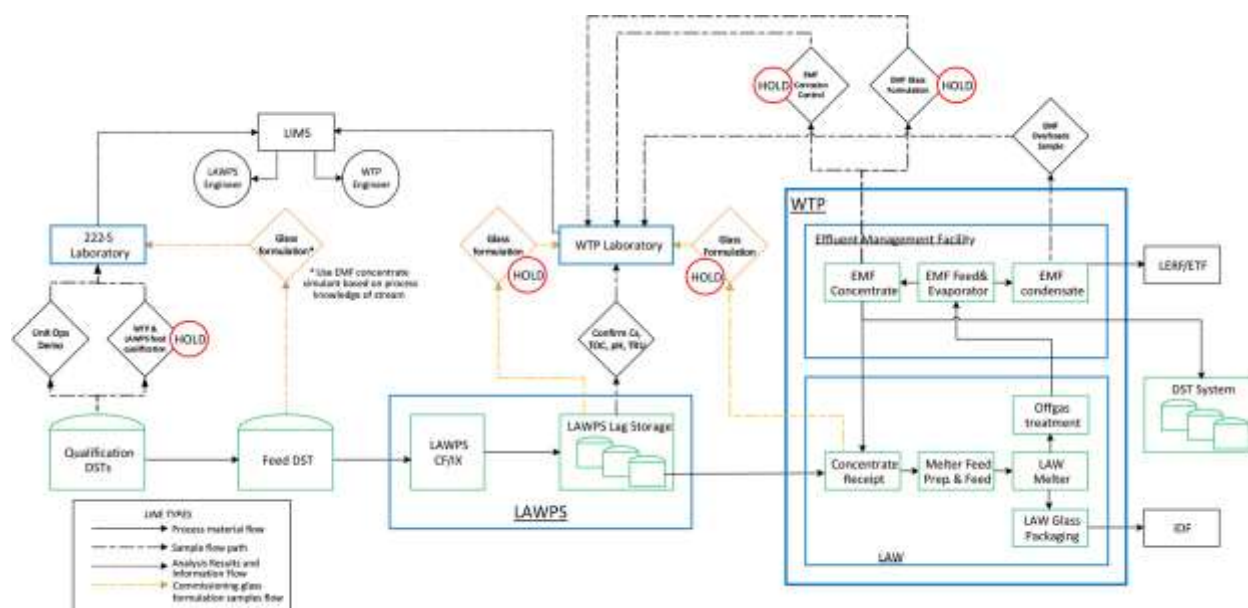


Figure 2: Integrated DFLAW Flowsheet

Collection of grab samples from only one DST riser was recommended during RIE discussions because of expected minimum undissolved solids and higher degree of homogeneity in LAW feed. Sampling from one DST riser would reduce the sampling time significantly, by at least three weeks. The technical basis to show sampling from single riser is comparable with sampling from two risers has been documented to support this approach. Another RIE recommendation was to have all qualification sample analysis and testing performed in the Hanford on-site laboratory, and seek the support of National Laboratory subject matter experts (SMEs) as needed for qualifying the staged feed campaigns. This on-site laboratory is already the point of receipt for all tank farm samples. The laboratory personnel have the unique site-specific knowledge and experience in routine handling and analyses of Hanford tank

waste samples. The use of an on-site laboratory avoids redundant LAWPS and LAW analyses and reporting activities while eliminating the packaging and transportation for off-site shipments. In addition, the information flow with both facilities will be streamlined for direct access via the same Laboratory Information Management System. This also allows sufficient time for the evaluation of LAW WAC parameters and a demonstration of the glass former addition step to verify the glass formulation algorithm for making acceptable glass product. The results from staged DST samples will be evaluated to establish processing conditions for the corresponding feed campaign, while eliminating steps that are not necessary for waste acceptance or process control decisions.

A leading indication of acceptable immobilized waste comes from the bench-scale testing results on feed qualification samples taken from the staged DST for each campaign. The results will verify the initial glass algorithm run output used to define glass former recipes and process knowledge that the treatment processes are operating within prescribed control parameters. Sampling and testing of immobilized glass performance is not required in feed qualification for authorization to dispose the immobilized LAW product in the Integrated Disposal Facility on the Hanford site. The initial feed qualification sampling and laboratory-scale glass formulation will provide sufficient information to indicate production of acceptable immobilized LAW product from the corresponding feed campaign. Once sufficient process knowledge is developed, it is expected that the laboratory-scale glass formulation will only be needed when a particular campaign parameter is outside the range of process history and confidence.

DATA REQUIREMENTS

The DQOs for DFLAW qualification sampling and data collection will be developed using WAC parameters and processing requirements for both LAWPS and LAW operations. The WAC for feed acceptance into LAW facility are established through an interface process among WTP, TOC and DOE. The WAC requirements including the physical and administrative interfaces are documented in the Interface Control Document for Direct LAW Feed, ICD-30 [2]. The WAC for LAWPS facility is documented in the RPP Integrated Flowsheet report [3]. Also, included in this report are the WAC for LAW facility.

The DFLAW-DQO development will include existing data inputs or historical information for determining the required data collection. The DQO process is iterative with initial efforts focused upon the type and quality of data required to support the decision to accept and process the staged LAW feed through unit operations in LAWPS and LAW facilities. The decision choices and inputs to the decision determines the data needs. The quality requirements for data collection will be based on waste acceptance criteria and error tolerances for analytes of

interest while taking into account sampling constraints and performance based measurement systems. The data quality requirements for process testing parameters will also be established in the DQO process. The decision to process the LAW feed requires sample analysis data for key parameters following bench-scale testing. Sampling and data collection for DFLAW qualification will be designed on the basis of inputs to data needs as determined from the flowchart in Figure 1. The iterative DQO process will lead to an optimized sampling and analysis plan designed to collect the needed data for protecting the design, safety and processing limits of the LAWPS and LAW systems. Samples will be collected as specified in the DFLAW-DQO. Data usability is part of sample and information flow shown in Figure 2.

FEED TRANSFER AND PROCESS CONTROL

The decision to qualify and accept the feed campaign will be based on qualification data from both WAC and process testing analyses. The results of integrated feed qualification activities are implemented using a batch processing methodology. Waste feed qualification data and the resulting batch processing methodology are used to determine an acceptable range of operator-controllable parameters needed to treat the transferred waste Campaign. The qualified feed campaign will be transferred to the LAWPS facility in 4000 gallon batches. The LAWPS process primarily involves filtration to remove solids (and thereby insoluble TRU components) and ion-exchange separation to remove cesium before the feed can be transferred to LAW facility for vitrification. The pretreated LAW is staged in LAWPS lag storage tanks, where it is sampled to analyze select parameters to confirm the LAW WAC are met and the LAWPS process is operating within control limits. A streamlining concept for this confirmatory sampling is to analyze the sample in the WTP laboratory to allow for combining with any WTP recycle stream or tank bottoms that may impact the glass recipe. This concept contains two long-term paradigm shifts. The first shift is that the WTP Laboratory would accept and analyze samples from sources outside WTP (TOC LAWPS). The second shift related to this concept is to rely on LAWPS in-line instrumentation rather than discrete and routine sampling and analysis events to ensure the process is operating within control limits. The feed is then transferred to the LAW concentrate receipt vessel (CRV) in up to 9000 gallon batches where it is sampled for process control, final glass recipe formulation and algorithm run for glass product compliance. The CRV and MFPV samples are analyzed in the WTP laboratory and could have different characteristics than the LAWPS lag storage sample due to CRV heels or Effluent Management Facility (EMF) evaporator bottoms that may be recycled. Again, the long-term goal is to gain enough confidence in process characteristics such that the CRV sample can be eliminated on the basis of data from DST feed qualification sample and process modelling outputs for glass recipes.

TOC and WTP contractor recognize that the commissioning and early operations of the DFLAW processes will require some additional sampling and hold points to ensure safe processing of the staged feed while establishing confidence the TOC-LAWPS and WTP-LAW processes are operating within their intended or acceptable limits. Additional hold points associated with commissioning and early operations are likely to be related to properties that limit a) performance of filtration, ion-exchange separation, and ion-exchange regeneration systems in LAWPS; b) feed transfer from LAWPS lag storage vessels to LAW CRVs; and c) defining final glass recipes related to feed transfer to LAW MFPVs. Sampling from the LAWPS lag storage vessels for select parameters will confirm satisfactory LAWPS treatment processing and verify that the LAW WAC are met prior to transfer of feed to LAW CRVs. This sampling will build confidence in the LAWPS process performance and the in-line instrumentation used to demonstrate the removal of insoluble solids, TRU and Cs-137. Sampling from the CRV will confirm the characterization of feed which is mixed with any remaining heels from the previous batch or any recycle streams from the EMF and ensure that glass recipes are defined based on final contents of each CRV batch. Once the impact of these heels and recycles are adequately characterized, then glass recipes can be calculated based on the qualification DST sample and process knowledge of heel and recycle streams within the LAW facility.

CONCLUSION

The RIE effort by One System team resulted in a feasible approach for integrating LAWPS and LAW feed acceptance requirements to vitrify Hanford tank waste supernatant waste while complying with facility design basis, safety basis, waste acceptance criteria, and glass product compliance. The defined qualification program will provide a systematic approach to test newly staged feed campaigns at bench-scale using actual tank waste samples. The required integration and basis for obtaining sufficient and necessary data to qualify the feed for DFLAW facilities have been defined. The integration also includes establishing DQOs for obtaining the needed data to support the decision for processing the feed. Work is in progress for completing the qualification program development, and for addressing RIE recommendations.

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