Low Activity Waste Pretreatment System (LAWPS)

Conceptual Design Approach-16568

David J Houghton

Washington River Protection Solutions, LLC
P.O. Box 850, Richland WA, 99352

Abstract

The Low Activity Waste Pretreatment System (LAWPS) will be capable of providing the Waste Treatment and Immobilization Project's (WTP) Low Activity Waste Facility (LAW) the feed material needed to operate both of the LAW melters at full capacity. LAWPS will receive supernatant from the Hanford AP tank farm, filter solids from the waste, remove cesium from the waste, and then stage the feed in storage tanks for supplying the LAW facility. The LAWPS project team is currently executing the preliminary design phase of the project leading to Critical Decision 2 (CD-2). CD-2 is the approval of the performance baseline. The Critical Decision 1 (CD-1) package was approved by the Department of Energy Deputy Under Secretary in May 2015. This paper will focus on creating and gaining approval of the CD-1 package and initiating execution of the preliminary design work. The intent of the paper will be to highlight the activities that facilitated achievement of the goals and present key activities that have been performed to increase the likelihood of preliminary design success. Initiating the immobilization of Hanford tank waste will be a tremendous accomplishment. LAWPS is one of the key projects required to achieve this accomplishment.

Executive Summary

The Low Activity Waste Pretreatment System (LAWPS) project provides needed connectivity between the Hanford Tank Farms and the Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste (LAW) facility in order to provide for a Direct LAW Feed capability.

The fundamental purpose of the LAWPS Project is to provide a capability to remove undissolved solids and radioactive cesium from Double-Shell Tank (DST) supernatants and feed the treated waste directly to the WTP LAW Vitrification facility for immobilization.

The LAWPS capability is essential to achievement of the overall Direct Feed LAW (DFLAW) mission. The mission requirements for DFLAW and the LAWPS portion of DFLAW are documented in the 'Mission Need Statement for the Low Activity Waste Pretreatment System at the Hanford Site' (March 2014). This document provides a sound basis for the need of a LAWPS and set the top-level performance criteria for

the LAWPS within the DFLAW mission. The DFLAW strategy capitalizes on Department of Energy Office of River Protection's (DOE-ORP) ability to complete construction and commissioning of the WTP LAW Vitrification Facility, Balance of Facilities, and the Analytical Laboratory (LAB) (collectively referred to as LBL) while technical issues at the WTP Pretreatment facility (PT) are being resolved. Direct feed of LAW through LAWPS is planned to be executed for the duration of technical issue resolution and subsequent startup of WTP PT in a manner that would safely make as much progress as possible on the treatment and disposal of LAW. This entails operations at the full capacity of two WTP LAW Vitrification Facility melters (30 metric tons of glass [MTG] per day).

Figure 1: Low Activity Waste Pretreatment System (LAWPS) and WTP Site Layout

The alternatives analysis performed as part of the conceptual design for LAWPS is derived from previous studies, an updated analysis of filtration and ion exchange technologies, and proven operational experience within the DOE Complex for the LAWPS fundamental facility configuration – i.e., utilization of a Cross Flow Filter (CFF) for solids separation and Ion Exchange (IX) using spherical Resorcinol Formaldehyde (sRF) as the IX media for Cs removal, sized to supply 1600 MT of waste sodium per year[1]. A comparison of the Functions and Requirements for LAWPS[2] to those of similar past Hanford projects and to similar facilities at other locations within the complex indicates that previous alternatives analysis results, conducted over the last eight years, are valid for LAWPS. Background information and justification for the selection of this facility configuration is documented in the *'Low Activity Waste Pretreatment System Alternatives Analyses Summary'*, RPP-RPT-58066. This alternatives exploration is compliant with DOE O 413.3B, *'Program and Project Management for the Acquisition of Capital Assets'*,

[1] This equates to 30 MTG/day for a Na_2O loading in glass of 20 wt%

[2] LAWPS functions and requirements are developed and documented in *Project T5L01 Low Activity Waste Pretreatment System Specification*, RPP-SPEC-56967, Rev. 2

requirements in that it results in a selected alternative that is technically achievable, affordable and provides the best value to the Department.

The LAWPS conceptual design is centered on a fundamental facility configuration that implements CFF and sRF IX. This conceptual design is more developed than typical conceptual designs in that operations and maintenance considerations have been folded into the facility layout and the results of several facility specific alternatives analyses have been incorporated in the design. Risks and handling actions have been identified and are manageable; opportunities for simplification and efficiencies have also been identified and documented in the *'Low Activity Waste Pretreatment System: Risk and Opportunity Management Plan'*, RPP-PLAN-57024. Technology development activities required to successfully deploy the conceptual design reflected herein are identified, planned and costed in the *'Technology Maturation Plan for the Low-Activity Waste Pretreatment System Project'*, RPP-PLAN-57181. The project cost and schedule estimate consistent with the contents of this conceptual design accounts for all project costs including design, procurement, construction, engineering during construction and facility start-up and commissioning.

The conceptual design report satisfies the requirements of DOE O 413.3B for a conceptual design, represents a LAWPS Project that is executable and represents a LAWPS that provides significant benefit to the Department.

Background

The Hanford Site located in Washington State contains the largest quantity of legacy tank waste in the Department of Energy (DOE) complex. Most of these nuclear wastes, resulting from the processing operations of defense nuclear materials, are stored in 177 underground storage tanks, containing an estimated 56 million gallons of hazardous and radioactive liquids, sludge, and saltcake with approximately 168 million curies of radioactivity *(Tank Waste Information Network System [TWINS] Best-Basis Inventory [BBI] Summary queried 12-17-2015)*. These tanks are located on the Central Plateau of the Hanford Site in 200 East and 200 West Areas, and are connected by a cross-site transfer system that is approximately 6.2 miles long (Figure 2).

The mission of the Office of River Protection (ORP) is to disposition all of the tank waste as described below:

- Retrieve the waste from Single Shell Tanks (SSTs) to DSTs and deliver to WTP
- Construct and operate the WTP to separate tank wastes into LAW and HLW fractions and vitrify the resultant feeds into durable, glass waste forms
- Develop and deploy supplemental treatment capability, if needed, to treat the LAW fraction which cannot be immobilized by the current WTP-LAW facility

- Develop and deploy supplemental pretreatment capability as needed
- Develop and deploy treatment and packaging capability for potential transuranic (TRU) tank waste at the Central Waste Complex pending determination of the final disposal pathway
- Deploy interim storage capacity for the immobilized HLW (IHLW) pending determination of final disposal pathway
- Dispose the immobilized low-activity waste (ILAW)
- Close the SST and DST tank farms, ancillary facilities, and associated waste management areas (WMAs)

The WTP Project was established for processing and converting Hanford tank waste into a vitrified (i.e., glass) form. The WTP process flow was designed to pretreat feed from the tank farms, separate it into HLW and LAW fractions, and vitrify each fraction in a separate facility. The vitrified waste would be poured directly into stainless steel canisters for containment during production. The IHLW would be interim stored onsite and eventually disposed at a HLW geologic repository, and the ILAW would be disposed on the Hanford Site.

The LAWPS Project provides for the early production of ILAW by feeding LAW directly from Tank Farms to WTP's LAW Facility, bypassing the PT. Prior to the transfer of feed to the WTP LAW Vitrification Facility, tank supernatant waste will be pretreated in the LAWPS to meet the WTP LAW waste acceptance criteria. The LAWPS will also facilitate the return to DSTs of the fraction of secondary liquid wastes generated by the WTP LAW Vitrification Facility that is not delivered to the Liquid Effluent Retention Facility/Effluent Treatment Facility (LERF/ETF) by the WTP Effluent Management Facility (EMF) [3]. The LAWPS is sized to support full utilization of both WTP LAW melters.

[3] The fraction of secondary liquid waste returned to the tank farms is significantly reduced by the WTP EMF thereby allowing for the creation of critically needed DST space via execution of the DFLAW mission. Note that, on average, DFLAW will be capable of processing approximately 2.3 Mgal of waste per year (at 5.6M Na concentration). The existence of the WTP EMF also significantly reduces the required duty of the Tank Farm's 242-A Evaporator over the DFLAW mission.

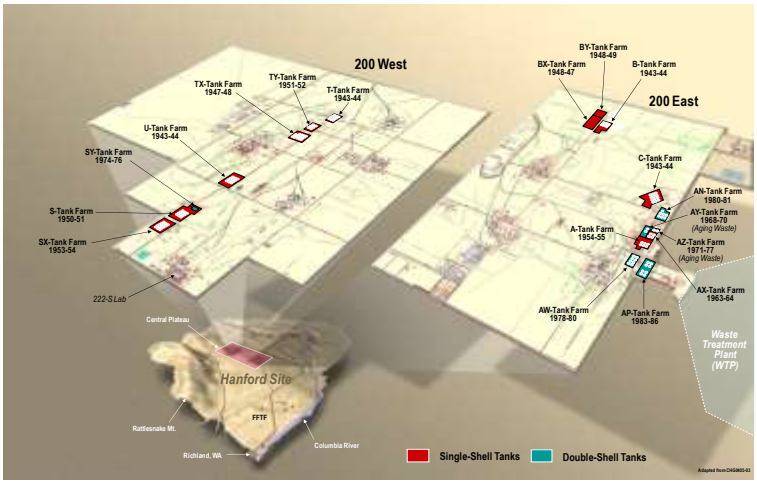


Figure 2: 149 Single-Shell Tanks and 28 Double-Shell Tanks (177 Total)

Conceptual Design Approach

In accordance with DOE Order 413.3B, *'Program and Project Management for the Acquisition of Capital Assets'*, the conceptual design process must ensure that a solution or alternatives are not only responsive to an approved need, but also technically achievable, affordable and will provide the best value to the Department.

This conceptual design provides a level of detail that is capable of providing a cost range and schedule leading into preliminary design. This concept will be further developed during preliminary design, the culmination of which is the establishment of the project cost and schedule baselines.

The Conceptual Design Report (CDR) *'Conceptual Design Report for the Low-Activity Waste Pretreatment System'* RPP-RPT-57120 includes technical descriptions, alternative evaluations, sketches, scoping calculations, outline specifications and supporting information for the recommended LAWPS configuration.

Table 1: Crosswalk Between 413.3B-Requirements for Conceptual Design and LAWPS Project Documentation	
413.3B Requirements for Conceptual Design	**Requirement Satisfied in LAWPS Project Conceptual Design Report (RPP-RPT-57120) and/or Supporting Document**
Scope required to satisfy the Program mission requirements	The LAWPS mission is contained in *'Mission Need Statement, Low Activity Waste Pretreatment System at the Hanford Site'*, Approved by David Huizenga, Acting Assistant Secretary for Environmental Management, March 17, 2014 The LAWPS mission requirements are translated into the LAWPS Project Technical Baseline requirements via RPP-46811, *'Direct Feed of the Low Activity Waste Program – Functions and Requirements'*, and RPP-SPEC-56967, *'Project T5L01 Low Activity Waste Pretreatment System Specification'.*
Project feasibility	RPP-RPT-57120, *'Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report'* RPP-RPT-58066, *'Low Activity Waste Pretreatment System Alternatives Analyses Summary Report'* RPP-PLAN-57181, *'Technology Maturation Plan for the Low Activity Waste Pretreatment System Project (T5L01)'*
Attainment of specified performance levels	RPP-RPT-57120, *'Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report',* Section 4.9, Reliability, Availability, Maintainability and Inspectability Assessment and Appendix E, Process Flow Diagram Sketches RPP-RPT-58203 *Supporting Calculations for the Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report*
Assessment of project risks and identification of appropriate risk handling strategies	RPP-PLAN-57024, *'Low Activity Waste Pretreatment System (Project T5L01): Risk and Opportunity Management Plan'* RPP-RPT-57120, *'Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report',* Section 6.9.1, Major Risks

Table 1: Crosswalk Between 413.3B-Requirements for Conceptual Design and LAWPS Project Documentation

413.3B Requirements for Conceptual Design	Requirement Satisfied in LAWPS Project Conceptual Design Report (RPP-RPT-57120) and/or Supporting Document
Reliable cost range and schedule estimates for the alternatives considered	RPP-RPT-57121, '*Low Activity Waste Pretreatment System (T5L01) Conceptual Design Cost Estimate and Schedule'*
Project criteria and design parameters; initiation of the Code of Record	RPP-SPEC-56967, '*Project T5L01 Low Activity Waste Pretreatment System Specification'*
Impact on the site Sustainability Plan	RPP-RPT-57120, '*Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report',* Section 6.14, Sustainability
Identification of requirements and features	RPP-SPEC-56967, '*Project T5L01 Low Activity Waste Pretreatment System Specification'* RPP-RPT-57120, '*Low Activity Waste Pretreatment System (T5L01) Conceptual Design Report'* RPP-RPT-58066, '*Low Activity Waste Pretreatment System Alternatives Analyses Summary Report'*

The LAWPS provides the capability for treating tank waste that separates solids (strontium and radioactive actinides are in the solids) and soluble cesium (Cs) from the liquid phase, resulting in two waste streams – a low activity waste (LAW) stream and a high level waste (HLW) stream. The LAW stream will be immobilized for on-site, near-surface disposal at the integrated disposal facility (IDF); the HLW stream will be returned to the double shell tank (DST) system for temporary storage and eventual immobilization at the Waste Treatment and Immobilization

Plant (WTP). Double-shell tank space has been allocated for the HLW return stream from LAWPS.

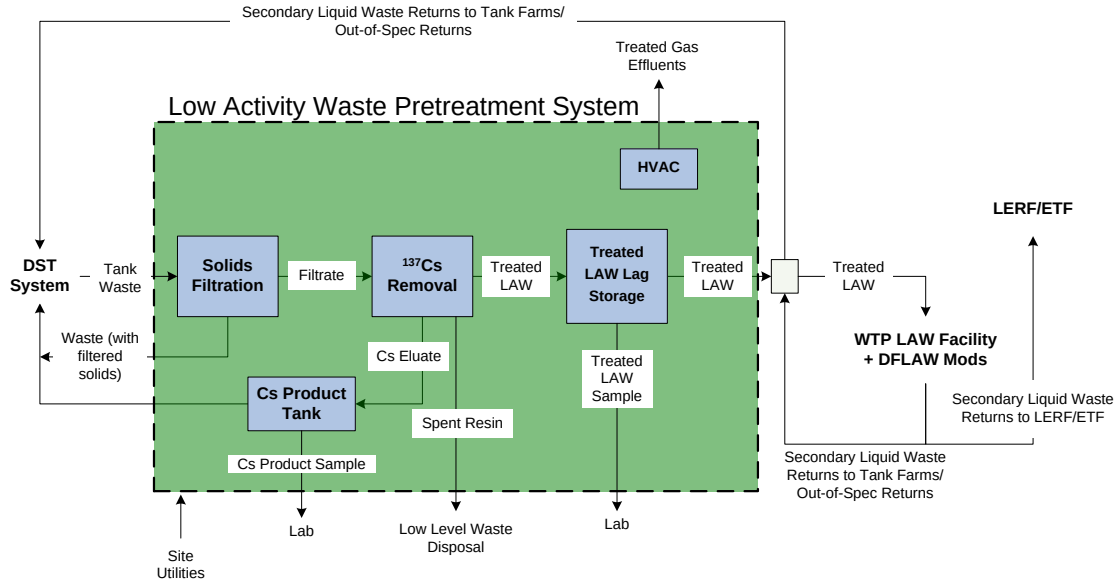


Figure 3: LAWPS Diagram

Key Performance Parameters (KPPs) identified for during the Conceptual Design will be finalized prior to Critical Decision 2 (CD-2) in line with the requirements of DOE O 413.3B.

Table 2: LAWPS Key Performance Parameters

Key Parameter	Performance
Facility throughput	Capacity to support WTP LAW Vitrification operations at 30 metric tons (MT) of glass per day, instantaneous rate. This translates into processing 1,600 MT of sodium from waste per year at a nominal 20 wt% sodium oxide (Na2O) loading in glass.
WTP LAW Vitrification Waste Acceptance Criteria	Performance for Conceptual Design defined by 'Early LAW Waste Receipt Criteria Revision', CCN 155899, from R. Hanson to S. A. Saunders, April 8, 2008. Note that this performance parameter will be documented in ICD-30 *'Interface Control Document for Direct LAW Feed',* 24590-WTP-ICD-MG-01-030, prior to CD-2.

Table 2: LAWPS Key Performance Parameters

Key Parameter	Performance
Solids removal	LAWPS shall be capable of removing undissolved (entrained) solids from tank supernatant waste. ^{90}Sr and transuranic (TRU) shall be limited in the feed to WTP as specified below. **Radionuclide** / **Maximum Radionuclide Concentration in Treated LAW, Ci/gmol Sodium** ^{90}Sr — 1.12E-03 TRU[a] — 1.30E-05 [a] TRU is defined as alpha-emitting radionuclides with an atomic number greater than 92, with half-life greater than 20 years (see HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*).
Cesium removal	The ^{137}Cs concentration in immobilized LAW must be < 0.3 Ci/m^3 to meet DOE M 435.1-1, '*Radioactive Waste Management Manual'*, requirements for near surface disposal. The maximum ^{137}Cs concentration in the feed from LAWPS to WTP must be less than or equal to 1.68 x 10-5 Ci/gmol Na, per CCN 155899.
Environmental compliance	Comply with all applicable environmental regulations. For example, WAC 173-303, '*Dangerous Waste Regulations'*, a subsection of which drives secondary containment for waste containing systems (e.g., encased waste transfer lines) and leak detection in secondary containment.
Future Facility flexibility	LAWPS facility layout accommodates expansion (e.g., ion exchange cells can be added adjacent to the cross flow filter vault); vault walls are large and can accommodate additional penetrations.

RPP-SPEC-56967, '*Low Activity Waste Pretreatment System Specification'*, captures the above KPPs as well as the balance of the technical requirements baseline for the LAWPS Project conceptual design effort. This specification establishes the system level functional performance, interface and design requirements for LAWPS. For the purposes of calculating conceptual design material balances, the design basis documented is based on an average of DST supernatants expected to be fed to the LAWPS during the first ten years of operation. Conceptual design shielding analysis and Hazard Category source terms are also included and are based on enveloping values. In the case of the Hazard Category source term, the values given in the

specification are a "worst case tank farm batch" plus two standard deviations. This requirements baseline is sufficient for the creation of a conceptual design that establishes a preferred alternative and cost range.

Alternatives Analysis for Conceptual Design

Selection of a preferred alternative is one of the key aspects of a conceptual design. The LAWPS alternatives analysis and selection process described in RPP-RPT-58066 and summarized herein complies with DOE O 413.3 B and integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration in order to evolve a cost-effective, preferred solution to meet a mission need (refer to DOE G 413.3-1, *Managing Design and Construction Using Systems Engineering for Use with DOE O 413.3A*, for more information).

The fundamental purpose of the LAWPS Project is to provide a capability to remove undissolved solids and radioactive cesium from Hanford supernatants and feed the treated waste directly to the WTP LAW Vitrification Facility for immobilization. The equipment (technology) selected for solids and radioactive cesium removal in LAWPS is the result of several years of Value Engineering and Decision Analysis studies that have concluded that Cross Flow Filtration (CFF) and spherical Resorcinol Formaldehyde (sRF) Ion Exchange (IX) are the best technologies to be applied to Hanford supernatants considering overall life cycle cost, scope, schedule, performance, and risk. The selection of these two technologies is documented in report RPP-RPT-58066; this section provides a summary level overview of the basis for selecting those technologies.

The basic principles applied to the LAWPS design are aimed at keeping operations and maintenance of the facility as simple as possible, with the following objectives:

- Remove solids that do not meet the WTP LAW facility waste acceptance criteria
- Remove cesium from the waste

These functions must be executed so that they:

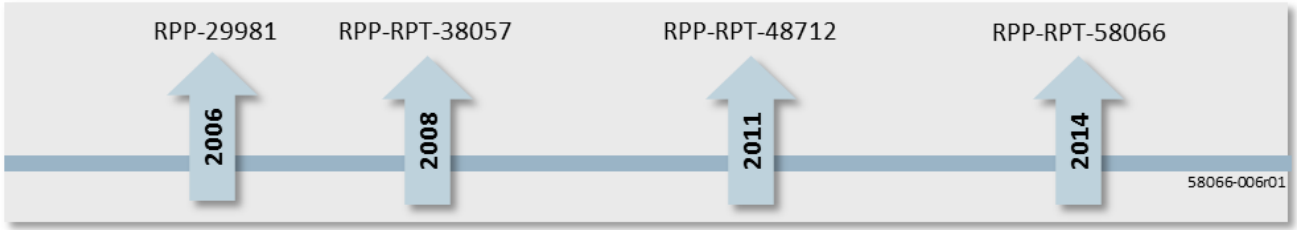
- Produce at least 1600 MT of sodium per year for WTP LAW facility feed
- Be a permanent capability
- Be ready in time to support the LAWPS schedule

The current alternatives analysis made use of technology evaluations completed as part of earlier projects through 2011. These projects are:

- 2006 Start LAW First (RPP-29981)
- 2008 LAW Interim Pretreatment System (RPP-RPT-38057)
- 2011 Supplemental Treatment System (RPP-RPT-48712)

A timeline of the above technology evaluations and pre-conceptual design descriptions used to support the current LAWPS project is shown below in Figure 4. Summary descriptions of the prior studies and their conclusions are discussed with further details provided in RPP-RPT-58066.

Figure 4: Timeline of Alternatives Analyses



RPP-29981, *Evaluation of Starting the Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste Facility First*
RPP-RPT-38057, *Project W-551 Interim Pretreatment System Technology Selection Summary Decision Report and Recommendation*
RPP-RPT-48712, *Treatment Technology Evaluation and Selection Report in Support of the Supplemental Treatment Project*
RPP-RPT-58066, *Low-Activity Waste Pretreatment System Alternatives Analyses Summary*

The current analysis accepted the results of these previous technology evaluations, but performed additional evaluations of advancements that have occurred since year 2011. These advancements evaluated are (RPP-RPT-58066):

- Additional advancements of rotary microfiltration (RMF) for solids removal
- Improvements in the selectivity of solvent extraction
- The development of commercial modular IX systems

Selection of Cesium Removal Technologies for LAWPS

Figure 5 shows a simplified logic diagram that shows the decisions used to select cesium removal technologies. The earlier technology evaluations eliminated fractional crystallization because of low sodium yield and potentially excessive variability in performance with feed composition (RPP-RPT-48712).

Those earlier evaluations also eliminated solvent extraction because the large number of contactors caused the facility cost to be excessive. Improvements since year 2011 in solvent extraction have improved the performance, but the cost is still higher than IX (RPP-RPT-58066). Additional development work would also be required to determine the cesium decontamination factors for Hanford waste (RPP-RPT-58066).

The commercial IX systems all use non-elutable IX resin. Two of these resins (CsTreat and Herschelite) were discounted based on the Hanford waste high pH level (RPP-RPT-58066). Crystalline silicotitanate (CST) could be used for short periods of time at high pH. Currently there is no disposal path at Hanford for non-elutable resin, thus a new Hazard Category 2 facility would be required for storage until a long term treatment path for the cesium-bearing resin could be identified and funded. For this reason the elutable resin, sRF, was selected (RPP-RPT-58066).

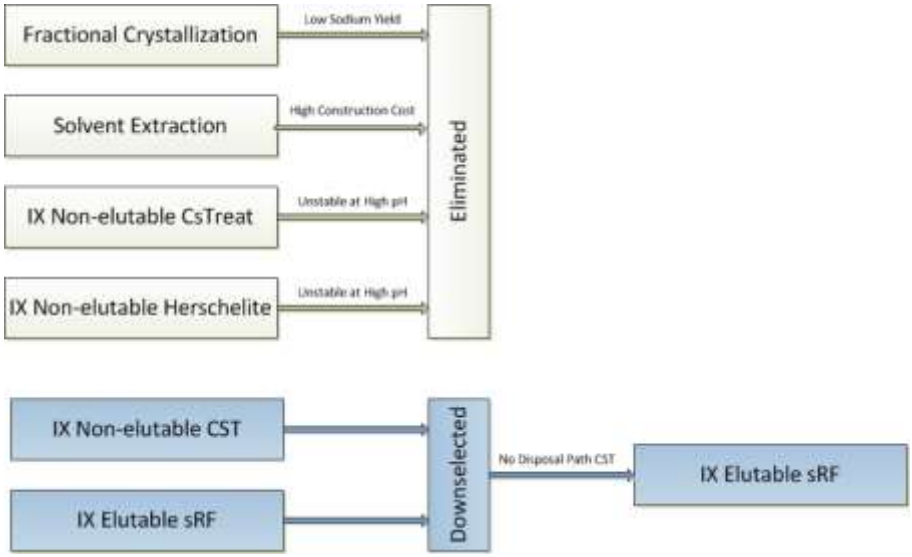


Figure 5: Simplified Logic Diagram for the Selection of Cesium Removal Technology

In addtion to the technical advantages of sRF discussed above, the cost comparison of elutable (sRF) vs. non-elutable (CST) IX media (see RPP-RPT-58066, Table A-20) showed a clear cost advantage to selecting sRF over CST.

Summary of Solids Removal Technologies for LAWPS

Figure 6 shows a simplified logic diagram that shows the decisions used to select solids removal technologies. The earlier technology evaluations eliminated gravity settling, centrifugation, and dead end filtration (RPP-RPT-48712).

Dead end filtration was eliminated because of rapid filter fouling. Centrifugation was eliminated because of frequent maintenance. Gravity settling was eliminated because it may not meet the requirement for solids removal. However, a gravity settling process will be used in the tank farms prior to transfers to the LAWPS to minimize solids for filtration.

Earlier evaluations also eliminated RMF (RPP-RPT-48712). However, there have been substantial improvements in RMF since 2011 in reliability. Consequently, an

extensive comparison of RMF and CFF was undertaken (RPP-RPT-58066). This comparison determined that both CFF and RMF could be used to meet the solids removal requirements and the advantages of one over the other were small (see RPP-RPT-58066, Appendix B), with CFF having a slight cost advantage (see RPP-RPT-58066, Table B-1). CFF was ultimately selected over RMF because of the favorable operational experience at other waste treatment facilities across the DOE complex. CFF also provides the Hanford site with operational experience prior to WTP PT startup, which includes CFF as part of the Pretreatment process.

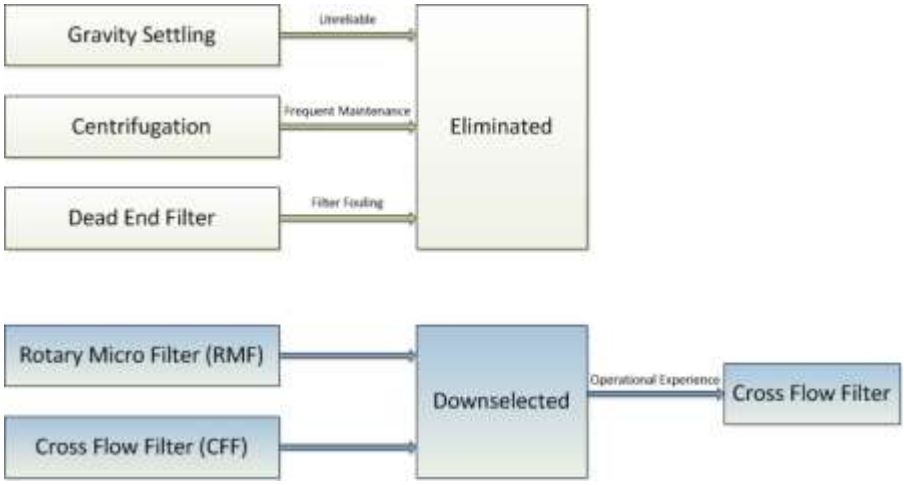


Figure 6: Simplified Logic Diagram for the Selection of Solids Removal Technology

Applicability of other DOE Facility Technologies

The current LAWPS technology selection is validated by the fact that the same unit operations (CFF with IX) have been successfully deployed at other Department of Energy waste treatment sites. LAWPS uses a more modern IX resin, which is more appropriate for a site without a disposal path for non-elutable resin. Notable examples of other successful projects employing CFF with IX include the West Valley Demonstration Site, Oak Ridge, and the Savanah River Solid-Liquid Separation Project.

Savannah River's Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit (ARP/MCU) facility and West Valley's Supernatant Treatment System (STS) meet technical requirements very similar to LAWPS. These two facilities are therefore selected as the appropriate facilities to benchmark the LAWPS Conceptual Design. West Valley used decanting and CFF for solids removal prior to IX which is the same configuration as the LAWPS conceptual design. ARP/MCU also uses CFF prior to Cs removal like the LAWPS conceptual design, but the ARP filter must filter Monosilicate Titanate (MST) along with the salt solution solids and ARP has a

secondary filter to protect MCU, a Hazard Category 3 facility. West Valley removed Cs with IX. LAWPS also removes Cs with IX, but West Valley used Zeolite, a non elutable IX media and LAWPS uses sRF, an elutable resin. West Valley's IX lessons learned are helpful to LAWPS conceptual design regardless of the differences in IX media.

Table 3 below lists several issues and successes that have been experienced during the operation of ARP/MCU and STS. The table relates the applicability to the LAWPS conceptual design.

Table 3: Other DOE Facilities Applicability to LAWPS Conceptual Design

Project	Issue or Success	Applicability to LAWPS
STS	Valves that permit switching lead and lag columns leak, contaminating polishing column	LAWPS simplified this design with fixed lead/lag columns; bypassing the lead column isn't an issue. LAWPS valve design and valve leaking consequences will be evaluated during preliminary design as valve manufacturers specifications become available
STS	Replacement of seal material in valves to material resistant to high radiation doses resulted in higher friction values than the valve was designed for	LAWPS must confirm adequate radiation tolerance on components and verify any modifications to achieve the desired radiation tolerance are performed correctly during preliminary design.
STS	Sluicing of IX media from the columns was successfully performed routinely, an air sparge was used to fluidize the media during sluicing.	sRF has been successfully sluiced from scale columns during testing for WTP; the STS information adds confidence in this feature of the LAWPS conceptual design.
STS	STS decant pump utilized a floating suction which effectively supported CFF. Two million gallons of waste were processed with only 1 auto-backpulse, in tank pump parts (rotating elbow	LAWPS will receive decanted supernatant from tank AP-107. The AP-107 pump design will be part of the DST upgrades project. WRPS plans to leverage SRS experience in successfully deploying and operating telescoping pumps versus floating suction pumps.

Table 3: Other DOE Facilities Applicability to LAWPS Conceptual Design		
Project	**Issue or Success**	**Applicability to LAWPS**
	and retrieval cable) were problematic.	
STS	Radiation probe on the decontaminated product line provided real time system performance information	LAWPS conceptual design includes radiation probes on the decontaminated product line
ARP/ MCU	ARP experienced plugging of the secondary filter, potentially indicating post filtration solids formation	LAWPS conceptual design does not have a secondary filter and the CFF is close coupled with the IX columns. Managing LAWPS feed is the primary fix for post filter precipitation. The LAWPS design is such that an unplanned the occurrence of solids formation would not occur until after IX; LAWPS has features in the downstream tanks to recover from solids formation.
ARP/ MCU	MCU relies on contact maintenance after the system is de-inventoried of the radioactive process fluids. As operating experience identified items that require frequent maintenance quick change out and semi-remote features were added to those items.	LAWPS conceptual design uses a similar maintenance philosophy to MCU. The Operational Research (OR) model will be used early in preliminary design to identify the frequent maintenance items allowing maintenance and reliability enhancing features to be added early in the preliminary design.
ARP/ MCU	The MCU contactors have experienced vibration issues.	LAWPS design has avoided rotating equipment when possible. For example, CFFs were selected over the RMFs; IX was selected over CSSX.

Table 3: Other DOE Facilities Applicability to LAWPS Conceptual Design		
Project	**Issue or Success**	**Applicability to LAWPS**
ARP/ MCU	The CFF had to be replaced due to depth fouling	The LAWPS design allows for addition of cleaning reagents, including the capability to soak the filter and pass reagent through the filter.

CSSX Caustic Side Solvent Extraction
SRS Savannah River Site

The project execution difference between STS, ARP/MCU and LAWPS are significant. LAWPS will be a new stand-alone facility while the others significantly utilized existing facilities. The design life for LAWPS is significantly longer than the original design life for the other facilities (it is noted that ARP/MCU has now been reviewed to be viable for a significantly longer life span). On the commonality side, ARP/MCU was designed and constructed far faster and an order of magnitude less expensive than the Salt Waste Processing Facility (SWPF), the full mission facility. Based on the referenced planning documents, LAWPS execution and costs are also faster and less expensive than those for the WTP PT facility.

Summary / Conclusions

Based on the Value Engineering and Decision Analysis studies completed as part of the Conceptual Design the LAWPS the preferred Near-Tank Treatment System consists of a CFF system for solids separation and elutable IX using sRF for cesium removal. Both unit operations will be located in a new system located between the AP Tank Farm and LAW Vitrification Facility.

Supernatant will be continuously transferred from Tank 241-AP-107 to the new LAWPS facility via dedicated transfer lines. The supernatant will be received into a Filter Feed Tank (FFT), and then fed into the CFFs at a high flow rate. The CFF system will produce filtrate by control of the filtrate line. The slightly higher solids content waste will be continuously returned to the 241- AP-107 Tank via dedicated transfer line. The fluid velocity will be kept high through the CFF to minimize solids buildup on the filter walls.

A large pump and 8-inch transfer lines are included in the design to circulate the waste through the CFFs at the necessary velocity. With high feed rate to the filters and a low filtrate production rate, most of the flow to the filters will be returned to the FFT, and heat will be produced through pumping. The FFT is therefore fitted with a cooling water jacket for removal of the pump heat. The CFFs are sized to be capable of concentrating the supernatant to approximately 10 wt% solids while maintaining the required filtrate production rate through the IX columns.

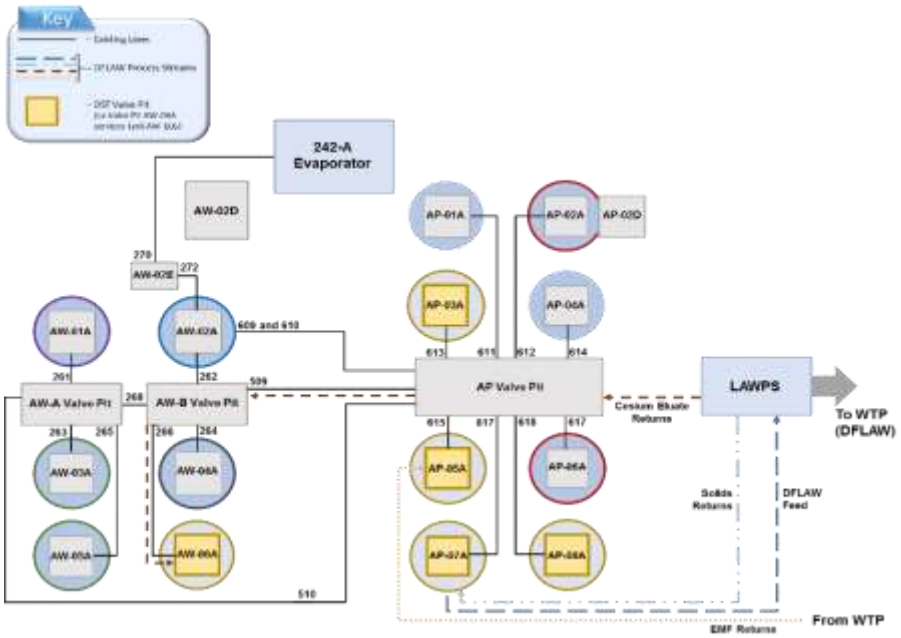


Figure 7: LAWPS / Tank Farm Layout

The filtrate will flow through two IX columns (lead and lag) in series. The filtrate will be fed into the top of the IX columns and will exit the bottom of the columns. The filtrate will flow first to the lead column and then to the lag column. After exiting the lag column, the LAW waste product will be transferred to one of three treated LAW Lag Storage Tanks. Treated LAW will then be transferred from the treated LAW Lag Storage Tanks to the WTP LAW Facility.

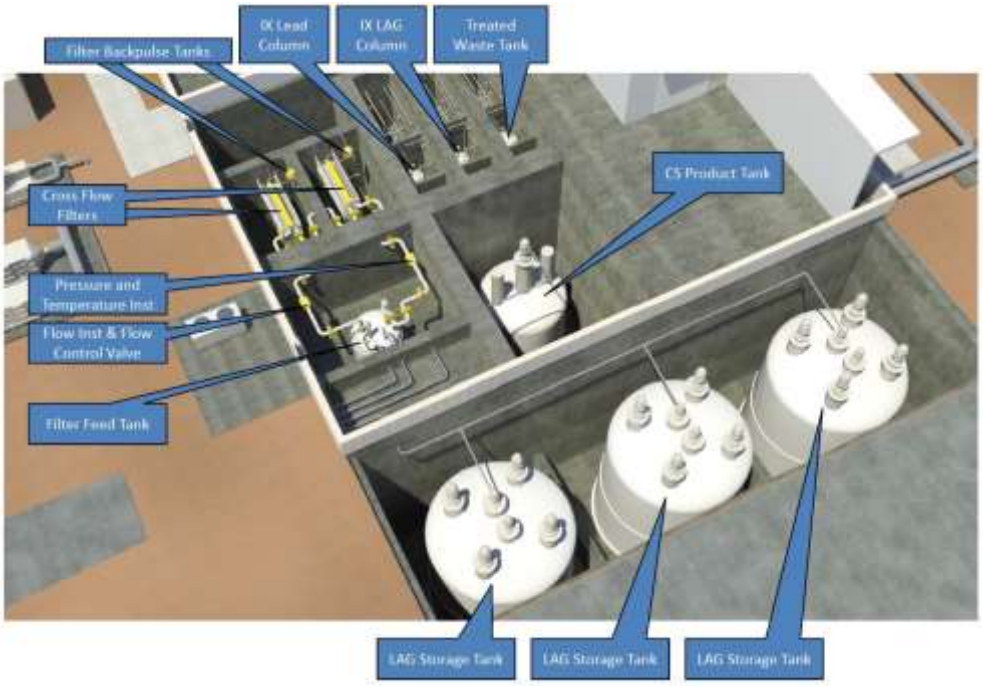


Figure 8: LAWPS Process Vaults

Successful operating experiences at other DOE sites have validated the selection of these core technologies for LAWPS including:

- West Valley Demonstration Site;
- Oak Ridge; and
- Savannah River Solid-Liquid Separation Project

These sites have successfully deployed and operated CFF paired with IX, providing overall confidence and reduced technical maturation risk and cost for the LAWPS Project.

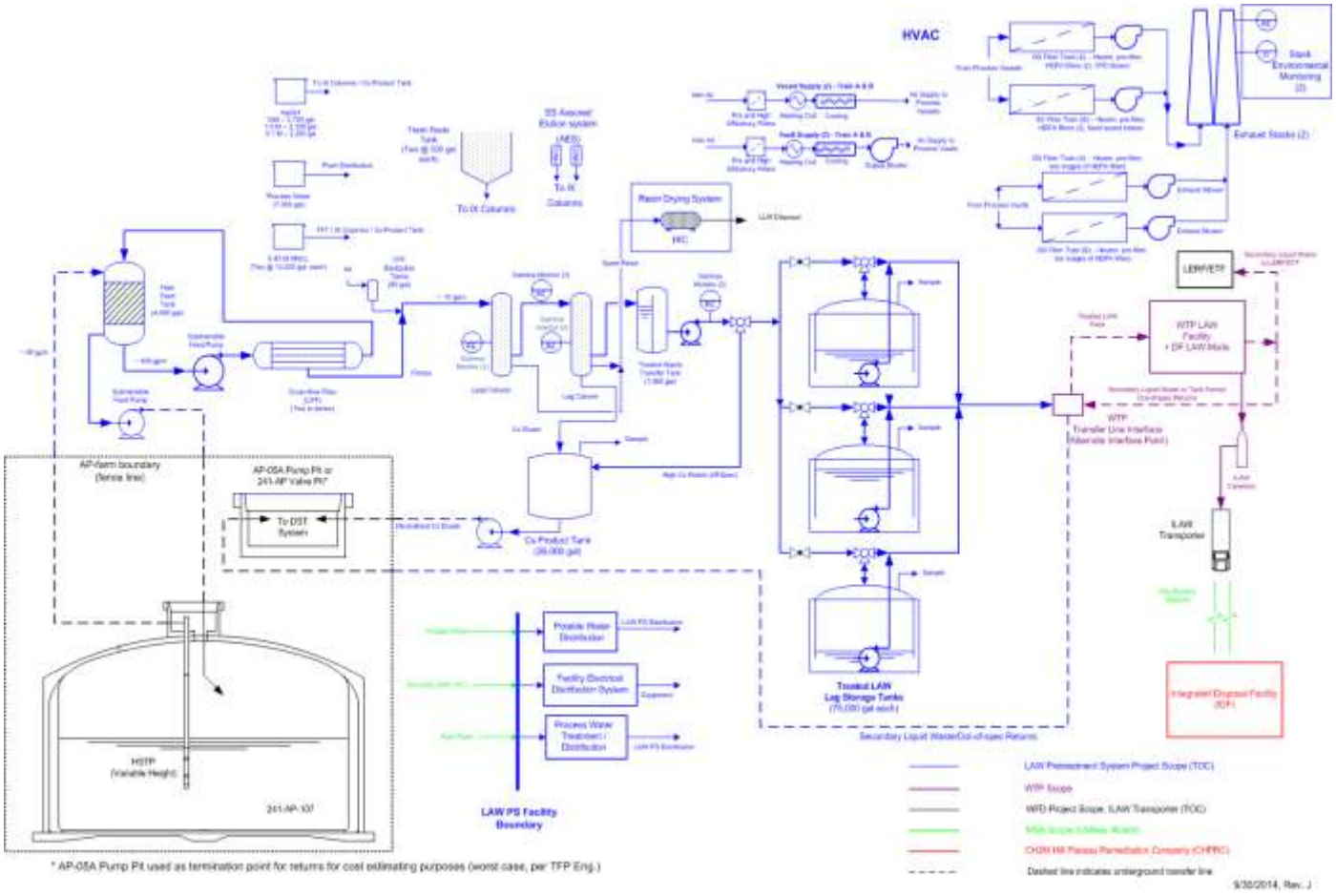


Figure 9: DFLAW / LAWPS System Diagram

Key Benefits:

- Early operational experience that can be applied to PT and HLW Facility
- Early opportunity to evaluate the operability, maintainability, and efficiency of critical PT chemical processing components in an operational facility
- Early training experience for WTP startup and operations staff
- Relief to the closely coupled nature of WTP operations, mitigating waste production sensitivity to facility unavailability
- Longer-term conditioned LAW feed capacity as a supplement to PT (post DFLAW mission) which could facilitate higher production rates for LAW immobilization

- A progressive development plan, consistent with anticipated project funding, that calls for near-term engineering development followed by simplified early operations, leading to full production

Key Design Features

- Equipment is sized with sufficient capacity to satisfy throughput requirements of 1600 MT of Na per year at 100% operating efficiency[4]
- Failed equipment items are removed, replaced, and disposed, and the need for a hot maintenance facility is eliminated
- Continuous feed recirculation between 241-AP-107 and the Filter Feed Tank (FFT)
- CFF for solids removal with back pulse and chemical cleaning capability
- The IX resin is elutable sRF
- Agitation and sampling of the Cs product tank
- Neutralized IX eluate is transferred to the AP transfer system
- Three new LAW lag storage tanks for robust feed capability
- All vaults have removable cover plates/blocks to provide access for maintenance
- Weather enclosure is to be erected over the primary process vaults

Safety Analysis/Classification

The LAWPS safety analysis and classification is being performed in accordance with DOE-STD-1189-2008, '*Integration of Safety into the Design Process'*. The results for Conceptual Safety Design Report (CSDR) are reported in RPP-58039.

The LAWPS facility exceeds Hazard Category 2 thresholds and is considered a major modification to the Hazard Category 2 Tank Farms facility. More specifically, the major modification includes the processing systems contained in the LAWPS vaults and associated support functions (e.g. resin handling). Systems located outside of the LAWPS vaults (i.e., transfer lines and waste transfer associated structures) are similar to those in the existing Hazard Category 2 Tank Farms facility and will follow applicable, existing design and safety basis requirements of the Tank Farms facility.

Environmental Compliance/Permitting

The LAWPS design will comply with applicable Washington State and Federal environmental requirements. RPP-SPEC-56967 specifies the applicable Washington State and Federal regulations, tank farm contractor standards, and relevant permits such that the completed detailed design will be compliant with existing regulations, standards, and permits.

[4] This supports full utilization of both WTP LAW Vitrification Facility melters

Engineering

Conceptual, preliminary, and final design as well as engineering during construction will be based on DOE Order 413.3B. The TOC has been directed by ORP to produce a 90% design CD-2 package to support the aggressive project schedule. Design products and supporting activities will meet technical, quality, and schedule requirements that flow down from contract documents (e.g. Statements of Work), specifications, respective procedures, codes, and standards.

Completion of the Conceptual Design (CD-1) represents the completion of the project definition phase. This was an iterative process; which defined, analyzed, and refined project concepts, and documented alternatives. This process was completed using a systems engineering methodology that integrated requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration, to develop a cost-effective, preferred solution to meet the mission need.

Procurement

Procurement of long-lead items/engineered items (CD-3A) will be obtained by using design/build specifications, competitively bid from fixed price subcontracts. Long-lead items are those items that are an engineered piece of equipment or require start of procurement in the Preliminary Design phase of the Project. The long-lead items have been identified for CD-3A.

Construction

A plant forces work review (PFWR) was performed and it was determined that the construction, fabrication, and assembly of the systems and subsystems will be executed by construction forces. A construction contractor will be competitively selected from a set of prequalified contractors.

References

1. RPP-RPT-57120 *'Conceptual Design Report for the Low-Activity Waste Pretreatment System'.*
2. RPP-RPT-58066 *'Low Activity Waste Pretreatment System Alternatives Analyses Summary'.*
3. DOE O 413.3B *'Program and Project Management for the Acquisition of Capital Assets'*.
4. RPP-SPEC-56967 *'Project T5L01 Low Activity Waste Pretreatment System Specification'*.
5. RPP-PLAN-57181 *'Technology Maturation Plan for the Low-Activity Waste Pretreatment System Project'*,
6. RPP-46811 *'Direct Feed of the Low Activity Waste Program – Functions and Requirements'.*

Note: All WRPS LAWPS documents (RPP---) referenced throughout this paper are designated for Official Use Only (OUO) and are not available at this time in the public domain.