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RPP-PLAN-43988
Revision 5

Technology and Innovation Roadmap

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TECHNOLOGY and INNOVATION ROADMAP

CHIEF TECHNOLOGY OFFICE

Published: September 2020

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T.A. Wooley
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EXECUTIVE SUMMARY

This Technology and Innovation Roadmap (Roadmap) presents a comprehensive, integrated assessment of the technology elements related to maintaining the River Protection Project baseline, reducing risk, and providing opportunity for improvement. These elements contribute to achieving successful completion of the Hanford Site tank waste cleanup mission. Key near-term U.S. Department of Energy (DOE), Office of River Protection (ORP) River Protection Project (RPP) mission needs with respect to the next 10 years are identified and prioritized. This Roadmap is used to assist with planning near-term scope to address technology development priorities in fiscal year 2021.

The Roadmap is updated annually with input from several key sources including DOE, Tank Operations Contractor Washington River Protection Solutions LLC management, Waste Treatment and Immobilization Plant contractors, Plateau Remediation contractors, and other knowledgeable subject matter experts. All of the known technology elements are identified by the appropriate subject matter experts and summarized via individual Technology Element Description Summary (TEDS) sheets.

There are over 100 technologies detailed in the Roadmap. In order to efficiently develop technologies, an organization has been established to oversee Roadmap development as required by DOE O 413.3b. To implement this requirement, the Chief Technology Office employs a two-step process to bring order and create a technology precedence based upon importance. First, representatives from the Tank Operations Contractor and ORP use the TEDS information to classify the technology elements into low-, medium-, and high-priority categories. This is based primarily on when the technology is needed to support RPP mission requirements. Second, those technologies selected by our ranking process are further evaluated and scored numerically to create an order of importance. Catalog sheets are then developed to summarize each technology element. The Roadmap is compiled and released for use within the DOE complex (DOE U.S. offices and National Laboratories). Subsequently, the representatives determine the utilization of resources to achieve needed technologies.

Specific areas of focus for technology development, as defined through this process, are provided by ORP for each fiscal year. At the request of ORP, the technology precedence, was not performed. For fiscal year 2020, RPP mission support needs were communicated and are identified in an End-State Technology Maturation and Execution (TM&E) chart. TM&E activities are identified to aid the integration of RPP mission programs and support achievement of RPP mission needs. There are seven mission programs divided into two areas:

1. Direct-Feed Low-Activity Waste Operations Support
    - Immobilized Low-Activity Waste Glass
    - High-Level Waste Operation Support
    - Tank-Side Cesium Removal & Low-Activity Waste a Pretreatment System
    - Cementitious Waste Forms.

2. RPP Mission Support
   - Alternate Retrieval Technology Identification and Development
   - Tank Integrity Technology Identification and Development
   - Sampling & Monitoring Technology Identification and Development
   - Worker Protection (Sampling & Monitoring, PPE, Investigations).

High-priority technology elements will be emphasized as potential solutions to the significant technical challenges facing the tank waste cleanup mission and enhance the safety of the workforce. The information presented in this Roadmap is used to guide technical needs supporting the RPP mission and to effect change as necessary.

Scheduling and mission impacts for technology elements in this Roadmap revision are mapped in the TM&E chart. The chart also identifies the benefits and risk mitigation potential for non-baseline technologies. Finally, the TM&E chart has the key mission decision points identified. In addition, a National Laboratory Technology Capabilities Matrix is included in Appendix D as Table D-1. Roadmap TEDS sheets are cross-walked to National Laboratory capabilities based on the need for National Laboratory support.

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2D	two-dimensional
3D	three-dimensional
AI	artificial intelligence
ALARA	as low as reasonably achievable
ASCEM	Advanced Simulation Capability for Environmental Management
ASME	American Society of Mechanical Engineers
BBI	best-basis inventory
CAM	continuous air monitor
CCN	cloud condensation nuclei
CD	Critical Decision
CEM	continuous emissions monitor
CH	contact-handled
CHPRC	CH2M HILL Plateau Remediation Company
COC	compound of concern
COPC	chemical of potential concern
CP	Central Plateau Contractor
CST	crystalline silicotitanate
CTF	Cold Test Facility
CTO	Chief Technology Office
DFAS	Data Fusion and Advisory System
DFHLW	direct-feed high-level waste
DFLAW	direct-feed low-activity waste
DOE	U.S. Department of Energy
DOT	Department of Transportation
DST	double-shell tank
DTW	dispose tank waste
Ecology	Washington State Department of Ecology
EOI	Expression of Interest
EPA	U.S. Environmental Protection Agency
EM	U.S. Department of Energy, Office of Environmental Management
EMAT	electromagnetic acoustic transducer
EMF	Effluent Management Facility
EROMS	Enterprise Risk and Opportunity Management System
ERSS	extended reach sluicing system
ETF	Effluent Treatment Facility
EWG	enhanced waste glass
FFRDC	Federally Funded Research Development
FID	flame ionization detection
FLTF	Field Lysimeter Test Facility
FT	flash thermography
FTIR	Fourier transform infrared
FWF	Federal Waste Facility
FY	fiscal year
GC	Grand Challenge
GC-FID	gas chromatography flame ionization detection
GC-MS	gas chromatography mass spectrometry
GEIT	General Electric Inspection Technology
GPS	global positioning system
GWPA	guided wave phased array
H	high priority
HIHTL	hose-in-hose transfer line
HLW	high-level waste
HWEE	Hanford waste end effector
IDAV	internal data access and visualization
IDF	Integrated Disposal Facility

LIST OF TERMS (Continued)

IEWO	inter-entity work order
IH	Industrial Hygiene
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
IMUST	inactive miscellaneous underground storage tank
ISF	Interim Storage Facility
IX	ion exchange
L	low priority
LAW	low-activity waste
LCO	Limiting Condition of Operation
LAWPS	Low-Activity Waste Pretreatment System
LDP	leak detection pit
LERF	Liquid Effluent Retention Facility
LIBS	laser-induced breakdown spectroscopy
LIDAR	light detection and ranging
LIF	laser-induced fluorescence
LLW	low-level waste
LOW	liquid observation well
LSW	liquid secondary waste
LTA	less than adequate
M	medium priority
MARS-V	vacuum-mode mobile arm retrieval system
MIP	medium isotope process
MTW	manage tank waste
MUST	miscellaneous underground storage tank
MW	manage waste
MWGS	mechanical waste gathering system
N	no
N/A	not applicable
NDE	nondestructive examination
NEMA	National Electrical Manufacturers Association
MW	manage waste
NDMA	n-nitrosodimethylamine
NRIS	New Riser Installation System
NRT	neutron radiographic testing
OEL	occupational exposure limit
OP-FTIR	open path Fourier transform infrared
ORP	U.S. Department of Energy, Office of River Protection
ORSS	off-riser sampler system
OTS	operator training simulator
Ox	oxidation
PA	performance assessment
PCT	product consistency test
PNNL	Pacific Northwest National Laboratory
PPE	personal protective equipment
PTR-MS	proton transfer reaction – mass spectrometer
PTW	process tank waste
RCCS	rotary core cutting system
RCRA	Resource Conservation and Recovery Act of 1976
Risk Registry	Enterprise Risk and Opportunity Management Program
Roadmap	Technology and Innovation Roadmap
ROI	return on investment
RPP	River Protection Project
RTW	retrieve tank waste
RVMS	residual volume measuring system

LIST OF TERMS (Continued)

SBS	submerged bed scrubber
SCBA	self-contained breathing apparatus
SLAW	supplemental low-activity waste
SME	subject matter expert
SPFT	single-pass flow through
SPP	Strategic Partnership Program
SRCA	stirred reactor coupon analysis
sRF	spherical resorcinol formaldehyde
SRNL	Savannah River National Laboratory
SST	single-shell tank
SSW	secondary solid waste
SWITS	Solid Waste Information and Tracking System
TBD	to be determined
TBI	test bed initiative
TEDS	Technology Element Description Summary
TEM	transmission electron microscope
TFF	tank farm fugitive
TM&E	technology maturation and execution
TOC	Tank Operations Contractor
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
TRU	transuranic
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989)
TSCR	tank-side cesium removal
TSR	Technical Safety Requirement
TWCS	tank waste characterization and staging
TWINS	Tank Waste Information Network System
UT	ultrasonic testing
UTL	upper tolerance limit
UV	ultraviolet
UV-DOAS	ultraviolet differential optical adsorption spectroscopy
UV-FTIR	ultraviolet Fourier transform infrared] stack monitor
VMC&R	Vapor, Monitoring, Characterization and Remediation
VMDS	vapor monitoring and detection system
VOC	volatile organic chemical
VWB	virtual workbench
WAC	waste acceptance criteria
WBS	work breakdown structure
WCS	Waste Control Specialists
WESP	wet electrostatic precipitator
WFD	waste feed delivery
WFE	wiped film evaporator
WIPP	Waste Isolation Pilot Plant
WMA	waste management area
WMIS	Waste Management Information System
WRF	Waste Receipt Facility
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant
XRD	x-ray diffraction
Y	yes

1.0 INTRODUCTION

On March 18, 2008, the U.S Department of Energy (DOE), Office of Environmental Management (EM) introduced the engineering and technology roadmap to support the complex cleanup effort. The National Academy of Sciences reviewed the EM Engineering and Technology Roadmap and issued report *Advice on the Department of Energy's Cleanup Technology Roadmap: Gaps and Bridges* (NAS 2009) documenting their gap analysis on the current state of the DOE Hanford Site cleanup effort.

The initial version (Revision 0) of this Technology and Innovation Roadmap (Roadmap) was released in May 2010 in response to the 2009 National Academy of Sciences report, and was in alignment with the philosophy of the then Assistant Secretary for EM of leveraging existing technology, using lessons-learned from across the complex, and incorporating "transformational technologies" to improve the mission. The scope for Revision 1 in 2015 was to identify technology gaps, prioritize technology needs, and advocate the use of National Laboratories to provide technical support, with an end goal of completing the River Protection Project (RPP) mission. The scope for Revision 2 in 2016 was the same; however, the content was updated to incorporate interim progress and changing mission priorities. The scope for Revision 3 in 2017 was the same as the other revisions; however, Revision 3 improvements included addressing integration of the DOE Office of River Protection (ORP) Grand Challenge (GC) technologies and updated technology prioritization and ranking processes based on ORP mission objectives.

Revision 4 in 2018 served to more closely link technologies with risks identified in the Washington River Protection Solutions, LLC (WRPS) Risk Register. New technologies are likely required to meet the obligations of the Tank Operations Contractor (TOC) and overall RPP mission. This Roadmap serves to further identify and determine the funded and non-funded waste remediation technologies in order to inform fiscal budget planning, prevent redundant efforts, guide National Laboratory research, and communicate with stakeholders. Revision 4 was intended to be a planning document, the conclusions of Revision 4 were based on technological priorities for fiscal year (FY) 2019. The Technology Element Description Summary (TEDS) sheets may identify cost from prior years, but this is merely for information purposes. Revision 4 required updates based upon ORP direction. The most direct way of creating the updates was through addendum RPP-PLAN-62988, *Addendum to the Technology and Innovation Roadmap Rev. 4*.

RPP-PLAN-62988 documents the results of an evaluation of a National Laboratory Support Plan for Direct-Feed Low-Activity Waste (DFLAW) Startup, Commissioning, and Operation (led by Savannah River National Laboratory and Pacific Northwest National Laboratory) against Revision 4 of the Roadmap and to expand the coverage it includes input from other Hanford Site contractors. To do this expansion, TOC WRPS reviewed National Laboratory capabilities identified to support an operating facility considering lessons learned from operating facilities across the DOE complex. In addition, WRPS contacted Waste Treatment and Immobilization Plant (WTP) and Plateau Remediation contractors to identify technology needs. The addendum contained two elements to supplement the Roadmap that expand the scope to include input from the National Laboratory matrix and other contractors.

This Roadmap is a direct update to Revision 4 and includes information in RPP-PLAN-62988. Additional input was provided at two Savannah River Site workshops: Cementitious Materials Technology

Exchange (2019) and DFLAW Glass Discussion Group (2019). The majority of the Roadmap is focused on highlighting technology needs as described in Section 5.0. These needs are identified in individual TEDS sheets (see Section 3.1) and are concisely summarized on one or two pages, known as "catalog sheets." Each Roadmap revision documents "current" technologies at a point in time. Revision 0 of the Roadmap highlighted 28 technologies. This has evolved to 117 current technology needs highlighted in Revision 5 with technology retirements and new additions. The Revision 5 technology list is the net amount resulting from 24 technology additions and 4 retirements. The retirements, as driven by development work completion and/or recognized lack of technology viability, are discussed in Appendix C. Revision 5 technology additions are shown in Table 1-1.

Table 1-1. New Technology Needs.

Manage Tank Waste	
MTW-83	Secondary Liner Bottom Damage Mitigation Technologies
MTW-84	Pipeline Forensic Inspection Technology
MTW-85	Remote Profilometry Use for Surface Examination
MTW-86	Protective Measures for Waste Transfer System Lines
MTW-87	Real-Time Localized Corrosion Monitoring Probe
MTW-88	Liquid Air Interface Sampler
MTW-89	Remote Concrete Surface Cleaning Apparatus
MTW-90	Water/Waste Volume Measurement for 242-A C-A-1 Vessel
MTW-91	Tank-Side Waste Evaporation
MTW-92	Tank Repair
MTW-93	Cesium Online Monitoring for TSCR
MTW-94	Internal Data Access & Visualization (IDAV)
MTW-95	Data Fusion and Advisory System (DFAS)
MTW-96	Exoskeleton
MTW-97	Continued Need for Improving Tools for Tank Farm Projects
MTW-98	Long Reach Robotic Tool for Tank Farm Pits
MTW-99	Tank Farm Smart Operating Procedures
MTW-100	Increased NDE Volume Inspection
Retrieve Tank Waste	
RTW-57	Plutonium/Absorber Mass Ratios Measurement
Process Tank Waste	
PTW-55	Chemical Process Modeling Software to Support DFLAW Operations
Dispose Tank Waste	
DTW-10	Test Bed Initiative Phase 2
DTW-12	Evaluation of Natural Analogues to Support Tailored Grout
DTW-13	Long-Term Durability of Cementitious Waste Forms
DTW-14	Complex-Wide Database for Cementitious Waste Form Properties

The current technologies are summarized by functional area in Table 1-2. The five functional areas are Manage Tank Waste (MTW), Retrieve Tank Waste (RTW), Process Tank Waste (PTW), Dispose Tank Waste (DTW), and Manage Waste (MW).

Table 1-2. Technologies by Functional Area.

Functional Area	Funded	Unfunded	Total
MTW	9	35	44
RTW	4	28	32
PTW	5	12	17
MW	1	4	5
DTW	5	5	10
Total	24	84	108

Revision 5 updates the End-State Technology Maturation and Execution (TM&E) chart, Figure 4-1, introduced in RPP-PLAN-62988. The TM&E chart depicts the current integration of technology maturation activities in support of major mission programs, highlighting RPP mission needs.

This document is compiled based on input from ORP, WRPS management, and knowledgeable subject matter experts (SMEs). These SMEs include TOC and ORP management as well as knowledgeable Hanford workers. All of the known technology needs are identified by the appropriate SMEs and summarized via individual TEDS sheets. The TEDS sheets document technology elements, which are components and/or systems requiring development that have been identified as a technology need. Section 3.0 describes how technology elements are aligned with mission initiatives; Figure 3-1 lists the sources of technology needs as well as how the technologies are accessed and prioritized. Individuals including the functional area SMEs, independents, and ORP use the summaries to clarify the technology elements into low-, medium-, and high-priority categories.

Technologies not only vary in priority, they cannot all be performed concurrently due to a lack of resources. In order to determine where available resources should be applied, high-priority technology elements are further evaluated to identify an overall hierarchy. That is, they are further evaluated to prioritize all technology elements within the high-priority category, ranking them from most important to lowest. Once the high-priority technologies are placed in hierarchal order, catalog sheets are developed to highlight each technology need. The document is subsequently compiled and released for use within the DOE complex.

2.0 BACKGROUND

An estimated 54 Mgal[1] of chemical and radioactive wastes are stored in 177 underground storage tanks at the Hanford Site in southeastern Washington State. This waste is the result of plutonium production for the nation's nuclear defense program and ensuing waste management. There are 149 single-shell tanks (SST) that were constructed between 1943 and 1964. There are 28 double-shell tanks (DST)[2] that were constructed between 1968 and 1986. Table 2-1 provides service life details of the DSTs.
Tank 241-AY-102 was taken out of service in 2012 due to primary tank leaking. The total number of active DSTs is therefore 27.

Table 2-1. DST Service Life.

Tank Farm	Number of Active Tanks	Construction Period	Initial Operation	Design Life	Current Age as of 2020
AY	1	1968-1970	1971	40	49
AZ	2	1970-1974	1976	20	44
SY	3	1974-1976	1977	50	43
AW	6	1976-1979	1980	50	40
AN	7	1977-1980	1981	50	39
AP	8	1982-1986	1986	50	34
Total	27				

The SSTs contain a complex and diverse mix of radioactive and chemical waste in the form of sludge, salt cake, and supernate. The SSTs have had nearly all pumpable liquid removed as part of the Interim Stabilization Program also known as salt well pumping; approximately 3 Mgal remain across 149 tanks. The different waste forms necessitate a variety of unique waste retrieval, treatment, and disposition methods. Descriptions and volumes of these waste phases are provided in Figure 2-1.

The Atomic Energy Commission built original DSTs to handle high-level waste from fuel reprocessing and waste management. The design has evolved as the Hanford mission changed. The RPP mission will require DST operation far beyond their design life. As such, maintaining the DSTs is a key mission goal. The waste in DSTs, though not as diverse as the SSTs, includes salt cake and sludge but primarily consists of supernate.

In 1989, the DOE, U.S. Environmental Protection Agency, and Washington State Department of Ecology (Ecology) entered into an enforceable compliance agreement with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989),[3] hereinafter referred to as the Tri-Party Agreement. The Tri-Party Agreement set forth milestones for tank waste retrievals and tank closures. DOE, the regulatory agencies, and the stakeholders all view tank waste cleanup as a top long-term priority. The tank waste must be retrieved, treated, immobilized, and permanently disposed to conform to the Tri-Party Agreement provisions. The project tasked with managing this program is the RPP.

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[1] Waste volumes fluctuate as a function of tank retrievals and other tank farms operations. The separate waste form volumes that total 54.1 Mgal (Figure 2-1) were derived from HNF-EP-0182, *Waste Tank Summary Report for Month Ending June 30th, 2020*.

[2] 27 of 28 are in service since tank AY-102 was taken out of service in 2012.

[3] This reference includes all applicable amendments of the Tri-Party Agreement.

Figure 2-1. Hanford Tank Waste Description.

Supernatant: 19 Mgal

Liquid above the solids or in large liquid pools in waste storage tanks.

Image taken from B-201 in-tank video (Video ID: 15714)

Saltcake: 24 Mgal

Soluble salts in waste storage tanks formed by the evaporation of liquid waste from nuclear reactor fuels reprocessing. Characterized by high porosity, interstitial liquid drainability, and crystalline texture.

Image taken from BY-111 in-tank video (Video ID: 13060)

Sludge: 11 Mgal

Insoluble hydrated metal oxides and fission products in waste storage tanks from nuclear reactor fuels reprocessing. Characterized by low porosity, reduced interstitial liquid drainability, and mud-like texture.

Image taken from T-104 in-tank video (Video ID: 17990)

The RPP mission (ORP-11242, *River Protection Project System Plan)* is to accomplish the following:

- Safeguard and safely manage the estimated 54 Mgal of nuclear waste stored in the Hanford Site tanks
- Treat the waste
- Ensure safe waste disposition to protect the Columbia River and the environment.

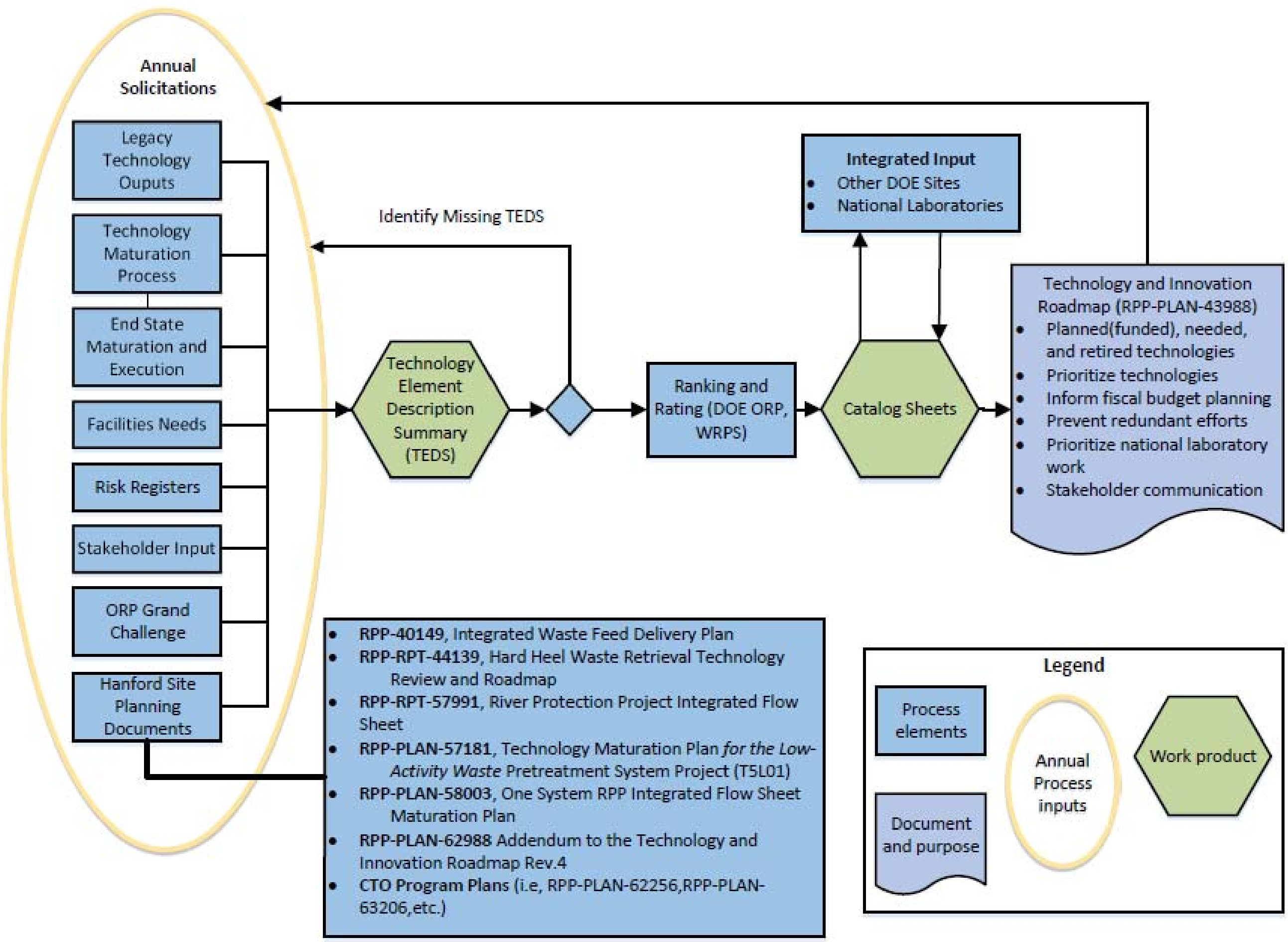
The Tank Operations Contract is a part of the RPP. The responsibility of the TOC is to accomplish the goals of the first bullet by storing, maintaining, and retrieving tank waste. The future responsibilities of the TOC are to feed tank waste to the WTP to accomplish the second bullet and help monitor the waste forms that are disposed (Integrated Disposal Facility) on the Hanford Site to accomplish the third bullet.

3.0 PROCESS SUMMARY

The technology maturation process as defined in TFC-PLN-90, *Technology Maturation Management Plan*, defines technology elements that are incorporated into TEDS sheets as necessary. After technology development needs are received from throughout the company, the DOE complex (contractors to DOE), and outside industries, Hanford Site planning documents are reviewed to identify any technology needs that were missed. Figure 3-1 highlights some of the planning documents that are reviewed. A TEDS sheet is generated for any additional technology needs.

This Roadmap is updated annually to incorporate the changing RPP technology needs. Figure 3-1 illustrates this process, which initiates with the solicitations of technology needs from a variety of sources.

Figure 3-1. Technology Development Process.



DOE	=	U.S. Department of Energy.	TEDS	=	Technology Element Description Summary.
ORP	=	Office of River Protection.	WRPS	=	Washington River Protection Solutions, LLC.

This process is used to ensure that the planning and strategic initiatives agree. These sources include: (1) previous year's Roadmap (Legacy Technology Outputs); (2) technologies derived through technology maturation; (3) TM&E chart (Figure 4-1); (4) stakeholder input; (5) facility needs; (6) Risk Register; (7) ORP GCs; and (8) programmatic planning documents. Most of these inputs are Hanford-centered, but the ORP GC obtained solicitations from industry, academia, and the DOE-wide complex. The GC program was discontinued and no new GCs have been produced since 2018.

3.1 Compiling Technology Element Description Summaries

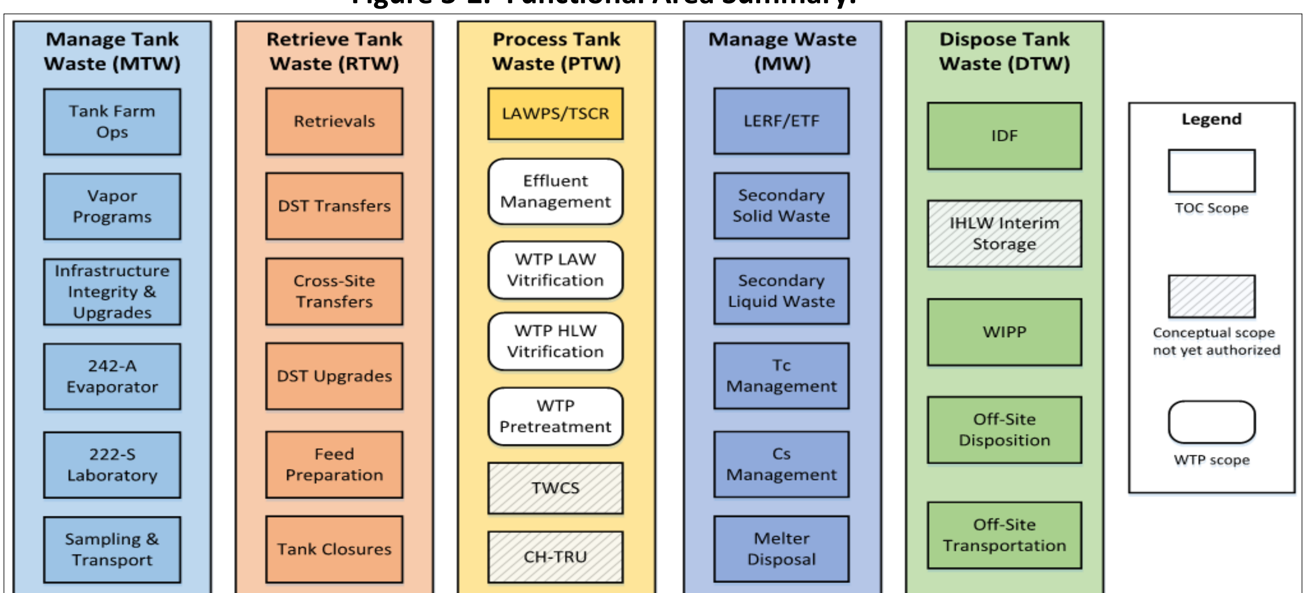
All of the known technology needs are identified by the appropriate subject matter experts via individual TEDS sheets. In Revisions 0 through 3 of the Roadmap, TEDS sheets were referred to as pro forma work sheets. Beginning in Revision 4 existing pro formas were updated to the TEDS format (see a sample TEDS form in Appendix A) and additional TEDS sheets were developed to address new technology needs.

The TEDS is a standardized work sheet ~~tool~~ that enables direct comparison of provided input. The TEDS sheets primarily include the following information:

- Funding status
- Technology summary
- Priority ranking
- Functional area
- Cost and schedule
- Points of contact
- Technology need
- Technology solution
- Technology maturation level
- National laboratory Involvement
- Grand Challenge relationship
- Technology impact and risk identification

To kick-off the request for TEDS sheets and ensure that the technology needs and gaps are comprehensively captured, the WRPS Chief Technology Office assembled a team with extensive experience in Hanford Site tank farms that spanned all mission functional areas.[4] This team included ORP and WRPS personnel, including managers and technical leads and individuals with field experience. The five mission functional areas are depicted in Figure 3-2. Having experienced Hanford Site members for all five functional areas served as a way to ensure all of the RPP mission requirements have coverage in the Roadmap.

Figure 3-2. Functional Area Summary.



CH-TRU	=	contact-handled transuranic.	IHLW	=	immobilized high-level waste.	Tc	=	technetium.
Cs	=	cesium.	LAW	=	low-activity waste.	TSCR	=	tank-side cesium removal.
DST	=	double-shell tank.	LAWPS	=	low-activity waste pretreatment system.	TWCS	=	tank waste characterization and staging.
ETF	=	Effluent Treatment Facility.	LERF	=	Liquid Effluent Retention Facility.	WIPP	=	Waste Isolation Pilot Plant.
						WTP	=	Waste Treatment and Immobilization Plant.

[4] The RPP mission functional areas are in alignment with the DE-AC27-08RV14800 Tank Operations Contract work breakdown structure and are discussed further in RPP-51303, *River Protection Project Functions and Requirements,* and RPP-RPT-56516, *One System River Protection Project Mission Analysis Report.* Although WTP technology development is identified in the functional framework, this Roadmap currently does not include WTP technology development activities.

The kick-off team was asked for additional technology needs that were not addressed by the previous year's TEDS, and new TEDS sheets were created if necessary. The primary input into the technology needs was the TM&E chart (see Figure 4-1 in Section 4.0).

Technology development is primarily driven by the need to mitigate risk and realize opportunity; therefore, the Risk Registries are significant input into the technology needs. The risks and opportunities are identified, managed, and assessed via the Enterprise Risk and Opportunity Management System (EROMS) which is also referred to as the Risk Registry. A key feature of the Risk Registry is known as handling actions. Handling actions propose what is or could be done about risks or opportunities to minimize or maximize the impacts to the work scope. A section of the TEDS form requests the risk and opportunity input. This input includes the handling actions that could be implemented by the proposed technology development. Additionally, opportunities identified in the Risk Registry are assessed for technology development application (see Appendix B).

Previously, the ORP Grand Challenge (GC) Workshop brought together members of DOE, National Laboratories, academia, contractors, and outside industries. ORP has not solicited GCs for FY 2020, but previous years' ideas that are related to technology development were incorporated into a TEDS sheet. The catalog sheets still indicate GC participation from previous years only.

3.2 Rating and Ranking Technologies

After all the technology needs are detailed on individual TEDS sheets, a rating and ranking process begins. There are over 100 technologies detailed in the Roadmap. In order to efficiently develop technologies, an organization needs to be established. The CTO employs a two-step process to bring order and create a technology precedence based upon importance. First, SMEs working in the area of need from the TOC and ORP use the TEDS information to classify the technology elements into low-, medium-, and high-priority categories. This is based primarily on when the technology is needed to support RPP mission requirements (see Figure B-1 in Appendix B).

A high priority is given to technologies needed to be field deployable within 1 to 4 years or if technology needs to begin within 5 years to meet the planned deployment date. This assignment is usually made by the author of the individual TEDS sheet but then must be validated by the SMEs. Only the high-priority TEDS sheets are moved to step 2.

In the second step, high-priority technologies are further evaluated and scored numerically to create an order of importance. Technology scoring is based upon applying three categories of assessment criteria (Table B-1 in Appendix B) that are weighted according to the pre-established level of importance. Assessment criteria used for technologies ranges from safety and DOE commitments to ease of implementation and mission enhancement. A series of questions are used to score the high-priority TEDS sheets so that there is only one top priority. This process is used to guide the order of importance. Details on the evaluation criteria and ranking protocols are included in Appendix B.

After scoring, catalog sheets are developed to summarize each technology element. The Roadmap is compiled and released for use within the DOE complex. Subsequently, TOC and ORP determine the utilization of resources to achieve needed technologies.

For this revision, TEDS sheets have been provided with a high, medium, or low priority category. At the request of ORP, high priority technologies have not been ranked.

3.3 Catalog Sheets

The catalog sheets make up Section 5.0 of this Roadmap. Information provided by the TEDS sheets is used to prepare the Roadmap catalog sheets highlighting each technology need. The catalog sheets are concise summaries of either funded (ongoing) or unfunded technology developments. They are shared with other DOE Sites, National Laboratories, and vendors as needed. Current funded activities are either high or medium priority. Funded technology developments are described on two pages identifying needs, solutions, risks, opportunities, activity duration, funding, interfacing contractor, and ORP contact information. The relationship between a TEDS and a catalog sheet is defined in Appendix A.

Unfunded technology developments are described on single page catalog sheets. Unfunded technology development catalog sheets contain similar information as the Funded catalog sheets but identify rough-order-of-magnitude cost and duration information. Unfunded technology developments are either high, medium, or low priority.

The basis of estimate provided for out-years is the best estimate for the work scope. The best estimate values may not reflect baseline funding, in which case the duration of performance could change.

3.4 Technology Roadmap Document

After catalog sheets are finalized, the Roadmap is compiled and released for use within the DOE complex. The Roadmap is a living document that is updated annually to accommodate changing needs of RPP mission. As such, it will be a key source for preparing program plans, transition plans, and out-year Roadmaps.

The extensive input to the Roadmap results in a multi-faceted output. The Roadmap is to be used as a planning tool for making informed budgetary decisions and to track the progress of ongoing technology development efforts (including completed tasks, or abandoned efforts which are identified as “retired”). Ideally the Roadmap will identify redundant efforts and gaps in technology development to optimize the approach taken to bring key technologies onto the Hanford Site (see Figure 3-1). Table C-1 in Appendix C identifies retired TEDS sheets for this Roadmap revision. Appendix C also describes CTO technology development achievements.

4.0 END STATE TECHNOLOGY MATURATION

This Roadmap reflects technology needs that support accomplishment of ORP's mission. This is known as the "End-State Technology Maturation." The End State is completion of technology development activities for equipment, system, and facilities . The End State is depicted in Figure 4-1, End State Technology and Execution. In previous years, ORP's technology development priorities were identified in formal documentation. In FY 2019, ORP priorities were communicated and included in Figure 2-1 of RPP-PLAN-62988. This Roadmap revision updates these priorities. Priority updates were communicated and are documented on Figure 4-1.

The TM&E chart includes an assessment of mission program impacts (i.e., return on investment) for key project technology development initiatives. Technology developments presenting potential significant benefit to accomplishing the RPP mission are included. These are identified as key opportunities for each mission program. RPP mission programs also include those technology development activities that envelop all of tank farm activities (e.g., worker protection).

4.1 End-State Technology Maturation and Execution

The Figure 4-1 TM&E chart depicts the integration of RPP mission programs and technology maturation activities supporting ORP priorities. There are seven mission programs divided into two areas:

1. DFLAW Operations Support
    - Immobilized Low-Activity Waste Glass
        - DTW-03, DTW-09, PTW-53, PTW-54
    - Tank-Side Cesium Removal & Low-Activity Waste a Pretreatment System
        - PTW-48
    - Cementitious Waste Forms
        - DTW-02, DTW-07, MW-02, PTW-23.
2. RPP Mission Support
    - Alternate Retrieval Technology Identification and Development
        - RTW-08, RTW-23, RTW-55
    - Tank Integrity Technology Identification and Development
        - MTW-11, MTW-15, MTW-73
    - Sampling & Monitoring Technology Identification and Development
        - RTW-01, RTW-02, MTW-76, MTW-77
    - Worker Protection (Sampling & Monitoring, PPE, Investigations)
        - MTW-24, MTW-69.

Major mission programs were identified from existing TEDS sheets, the National Laboratory Technology Capability Matrix (Appendix D), input from other Hanford Site contracts and ORP-11242. ORP-11242 calls for retrieval and closure of the SSTs and support of key mission milestones (e.g., Consent Decree Milestone, Tri-Party Agreement). Development activities were mapped to the major mission programs along with corresponding TEDS identification.

The TM&E chart employs a color coding of activities. This enables a quick visual understanding of end-state support. The color codes are:

- Opportunities (Green) – Technology development basis that could have substantial positive impact on the River Protection Project lifecycle cost and schedule and/or program risk.
- Return on Investment (Yellow) – Describes the technology development benefits (estimated cost savings, schedule savings, and risk reductions) to the RPP mission
- Baseline Activities (Blue) – ORP-11241, System Plan, Baseline Case
- Risk Mitigation (Orange) – Technology development activity basis for enhancement and efficient execution of the WTP mission
- Programmatic Milestones (Green Triangle) – Pending decisions that require technology support.
- Key Decisions (Red Diamond) – Decisions concerning technology deployment in support of mission milestones

Technology initiative funding profiles, needed to support the mission program milestones, are provided. Funding and schedule beyond FY 2020 are planning estimates. Technology development priority and funding profiles are reassessed on an annual basis.

The high-ranking technology elements documented in this Roadmap should be considered as planning insights. As potential funding becomes available, the unfunded high-ranking elements represent potential technology ideas that can improve operational flexibility, increase processing rates, decrease costs, and/or increase safety. This document is updated annually to reflect changing priorities, changing mission needs, and completed development activities.

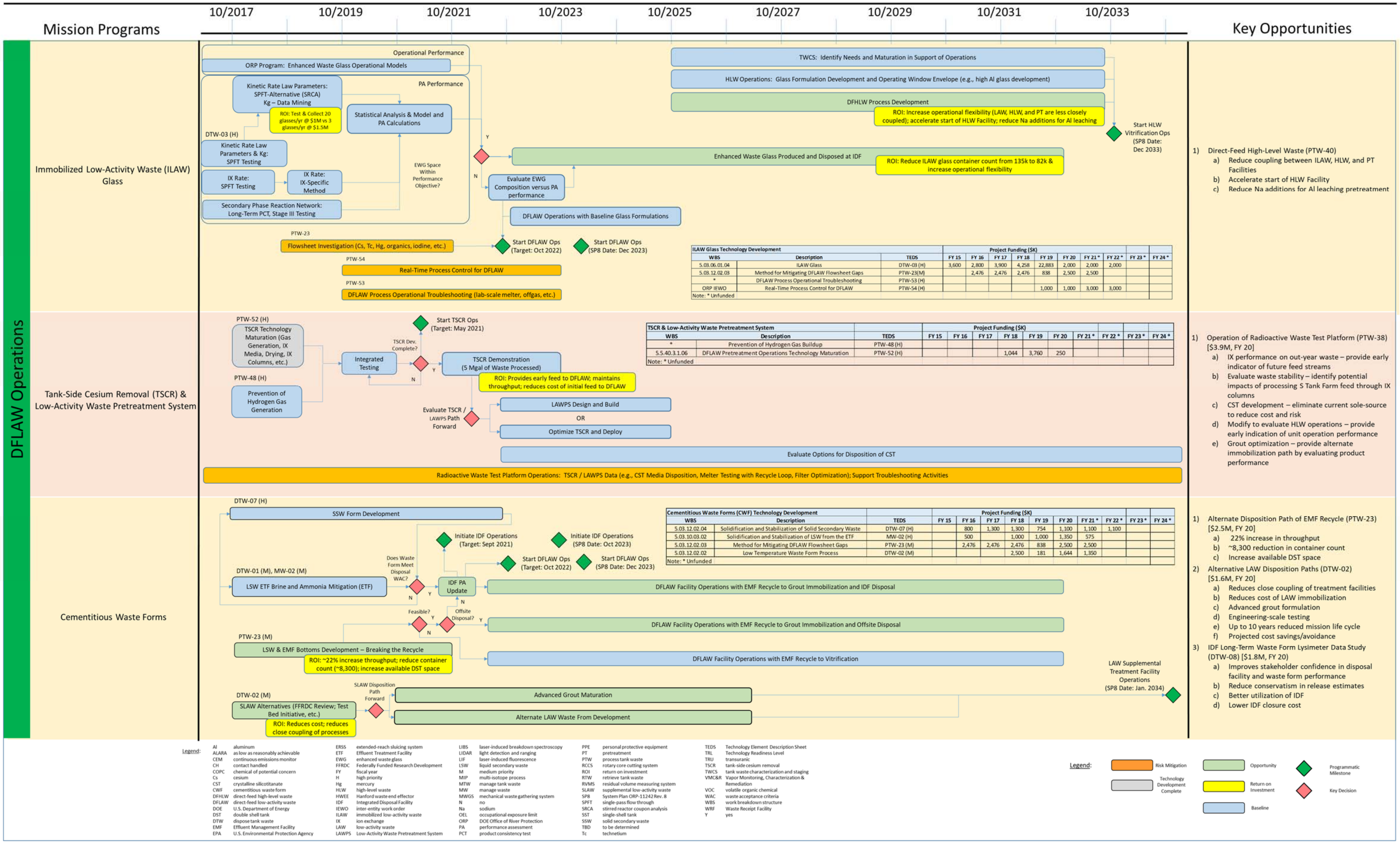
4.2 Transition to Operations

Transition equipment, systems, and facilities from start-up and commissioning to field operations may require the deployment of different technologies. Additional technology development and/or studies may be required to support field operations.

Technologies developed during start-up and commissioning focused on resolving technical basis questions, establishing regulatory and environmental bases, and supporting process development. During transition to operations, technology development is anticipated to focus on:

- Troubleshooting operational upsets,
- Improving process throughput,
- Resolving technical challenges associated with wider ranges of feed, and
- Reducing operational risk during DFLAW operations.

Figure 4-1. End-State Technology Maturation and Execution Chart. (2 sheets)

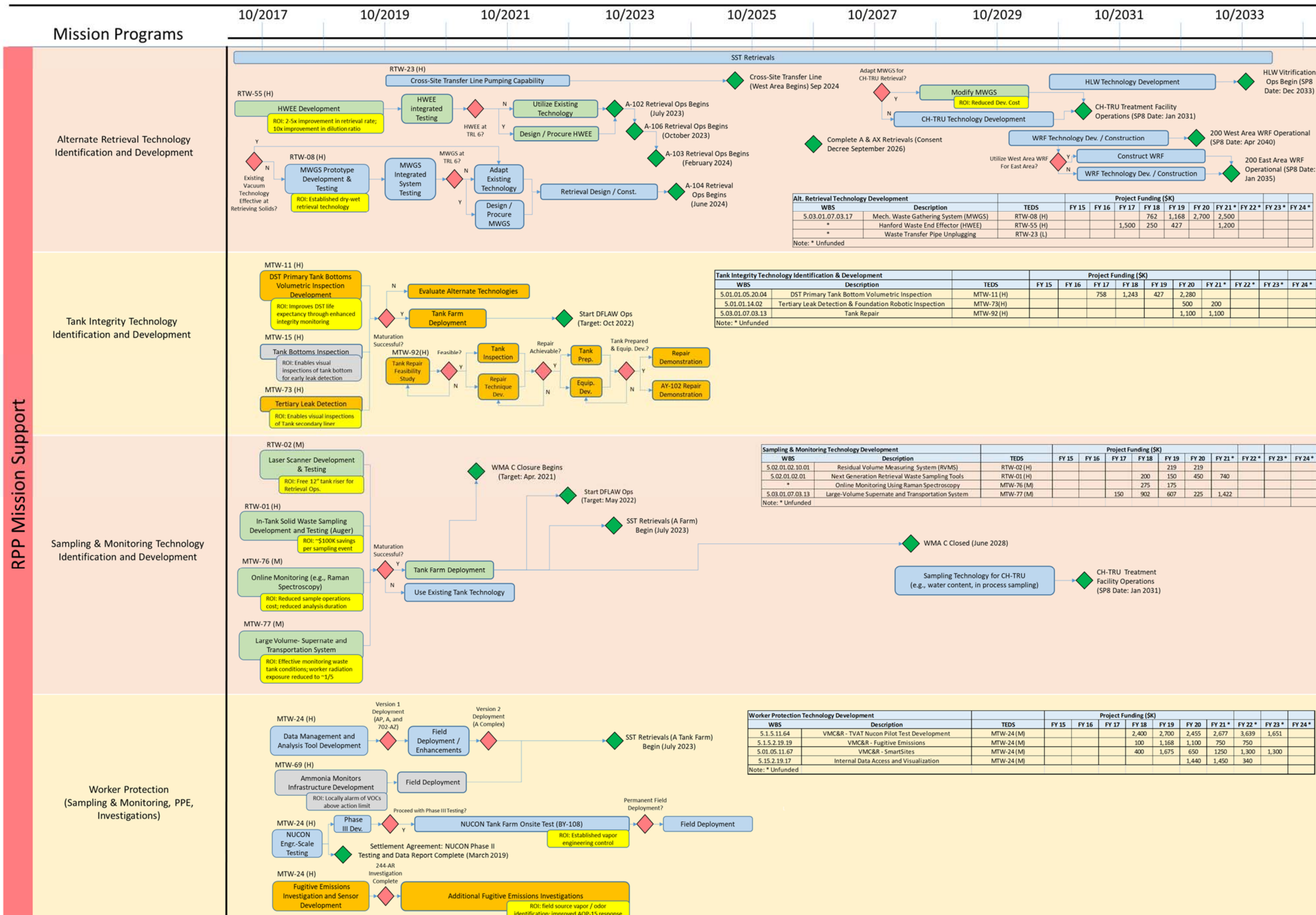


ILAW Glass Technology Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.03.06.01.04	ILAW Glass	DTW-03 (H)	3,600	2,800	3,900	4,258	22,883	2,000	2,000	2,000		
5.03.12.02.03	Method for Mitigating DFLAW Flowsheet Gaps	PTW-23(M)		2,476	2,476	2,476	838	2,500	2,500			
*	DFLAW Process Operational Troubleshooting	PTW-53 (H)										
ORP IEWO	Real-Time Process Control for DFLAW	PTW-54 (H)					1,000	1,000	3,000	3,000		
Note: * Unfunded												

TSCR & Low-Activity Waste Pretreatment System			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
*	Prevention of Hydrogen Gas Buildup	PTW-48 (H)										
5.5.40.3.1.06	DFLAW Pretreatment Operations Technology Maturation	PTW-52 (H)				1,044	3,760	250				
Note: * Unfunded												

Cementitious Waste Forms (CWF) Technology Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.03.12.02.04	Solidification and Stabilization of Solid Secondary Waste	DTW-07 (H)		800	1,300	1,300	754	1,100	1,100	1,100		
5.03.10.03.02	Solidification and Stabilization of LSW from the ETF	MW-02 (H)		500		1,000	1,000	1,350	575			
5.03.12.02.03	Method for Mitigating DFLAW Flowsheet Gaps	PTW-23 (M)		2,476	2,476	2,476	838	2,500	2,500			
5.03.12.02.02	Low Temperature Waste Form Process	DTW-02 (M)				2,500	181	1,644	1,350			
Note: * Unfunded												

Figure 4-1. End-State Technology Maturation and Execution Chart. (2 sheets)



Alt. Retrieval Technology Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.03.01.07.03.17	Mech. Waste Gathering System (MWGS)	RTW-08 (H)				762	1,168	2,700	2,500			
*	Hanford Waste End Effector (HWEE)	RTW-55 (H)			1,500	250	427		1,200			
*	Waste Transfer Pipe Unplugging	RTW-23 (L)										
Note: * Unfunded												

Tank Integrity Technology Identification & Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.01.01.05.20.04	DST Primary Tank Bottom Volumetric Inspection	MTW-11 (H)			758	1,243	427	2,280				
5.01.01.14.02	Tertiary Leak Detection & Foundation Robotic Inspection	MTW-73(H)						500	200			
5.03.01.07.03.13	Tank Repair	MTW-92 (H)						1,100	1,100			
Note: * Unfunded												

Sampling & Monitoring Technology Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.02.01.02.10.01	Residual Volume Measuring System (RVMS)	RTW-02 (H)					219	219				
5.02.01.02.01	Next Generation Retrieval Waste Sampling Tools	RTW-01 (H)				200	150	450	740			
*	Online Monitoring Using Raman Spectroscopy	MTW-76 (M)				275	175					
5.03.01.07.03.13	Large-Volume Supernate and Transportation System	MTW-77 (M)			150	902	607	225	1,422			
Note: * Unfunded												

Worker Protection Technology Development			Project Funding ($K)									
WBS	Description	TEDS	FY 15	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21 *	FY 22 *	FY 23 *	FY 24 *
5.1.5.11.64	VMC&R - TVAT Nucon Pilot Test Development	MTW-24 (M)				2,400	2,700	2,455	2,677	3,639	1,651	
5.1.5.2.19.19	VMC&R - Fugitive Emissions	MTW-24 (M)				100	1,168	1,100	750	750		
5.01.05.11.67	VMC&R - SmartSites	MTW-24 (M)				400	1,675	650	1250	1,300	1,300	
5.15.2.19.17	Internal Data Access and Visualization	MTW-24 (M)						1,440	1,450	340		
Note: * Unfunded												

Key Opportunities

Alternate Retrieval Technology Identification and Development

1) ERSS Modifications (RTW-34)
   a) Improve efficiency of waste removal by enhancing range of motion of ERSS (utilize less arms during retrieval and avoid obstructions)
   b) Increase pumping capability over greater range of solids rheological properties
2) High-Radiation Hose Material Testing (RTW-10)
   a) Increased lifecycle of hose-in-hose exposed to high-radiation environment and reduce cost
3) Development of an RCCS to Improve Access Inside the Tanks (RTW-12) ($1.8M, FY20)
   a) Reduced worker exposure during core drilling activities
   b) Increases riser size, increasing range of retrieval technologies, including commercial off-the-shelf technologies

Tank Integrity Technology Identification and Development

1) Automated DST Annulus Camera System (MTW-09)
   a) Reduce cost and exposure of annulus inspections
   b) Increase frequency and timeliness of event response
2) Radiation Tolerant Multi-Use Manipulator (MTW-81)
   a) Enhanced sensor deployment method, reducing cost and exposure

Sampling & Monitoring Technology Identification and Development

1) Tank Waste Characterization and Identification (MTW-37)
   a) Improved equipment reduces uncertainty with analytical results
   b) Improves exposure to technicians ALARA
2) Use of Sonar and Ultrasound to Quantify Solids in DSTs (RTW-44)
   a) Reduced uncertainty in solids measurements
   b) More accurate measurements reduce conservatism in tank waste evaluations
   c) Reduced schedule for volume determination
   d) Reduced dose to workers and simplifies measurement technique
3) Three-Dimensional Flash LIDAR to Map Waste Tanks (RTW-53)
   1) Reduced uncertainty in residual measurements
   2) Reduced schedule for tank waste mapping
   3) Reduced dose to workers and simplified measurement technique

Worker Protection (Sampling & Monitoring, PPE, Investigations)

1) Self-Diagnosing Continuous Air Monitoring (MTW-72)
   a) Minimize need for maintenance and personnel to service equipment during daily rounds
2) Autonomous Robotic Platform (MTW-79) [$0.2M, FY 19]
   a) Reduced worker exposure through reduced tank farm entries
   b) Collect tank and vapor data in remote farms prior to initiating waste-disturbing activities
   c) Enhance tank farm walk-down capabilities
3) Mobile Proton Transfer Reaction – Mass Spectrometer (MTW-68)
   1) Allows for near real time detection (e.g., ultraviolet – differential optical spectrometer) of COPCs at OELs
   2) Improved temporal resolution, low part per trillion sensitivity and extremely high mass resolution
4) CEM (MTW-24)
   a) Stack, area, and headspace monitor
   b) Autonomous, programmable whole-air sampling capability

5.0 MISSION TECHNOLOGIES AND INNOVATIONS

This section is dedicated to the presentation of the catalog sheets of all technologies. These are organized by the five basic functional areas (shown in Figure 3-2):

- Manage Tank Waste (MTW)
- Retrieve Tank Waste (RTW)
- Process Tank Waste (PTW)
- Manage Waste (MW)
- Dispose Tank Waste (DTW).

Within each function area, the catalog sheets are further divided into two groupings:

- Funded
- Unfunded.

The Funded catalog sheets are two pages. The designation of Funded indicates an ongoing funded effort. The Unfunded catalog sheets are one page. The designation of Unfunded indicates a proposed technology need that is currently unfunded. Each grouping of Funded and Unfunded catalog sheets are arranged alpha numerically.

5.1 Manage Tank Waste

The MTW functional area requires that the radioactive waste liquids, salts, and sludges be maintained in a safe, regulatory-compliant manner (pursuant to Tri-Party Agreement requirements). This includes safeguarding the overall integrity of the tanks and tank infrastructure and safely managing the waste contents. Tank farms management involves monitoring the tank contents and surrounding soil, upgrading aging infrastructure and equipment (as required), providing contingency storage in the event of a tank failure, and remediating vadose zones where waste has historically leaked to the environment.

The tank farms infrastructure must also be upgraded to support the DFLAW initiative. WRPS plans to upgrade utilities, transfer lines, and support facilities to deliver low-activity waste (LAW) feed directly to the WTP LAW Vitrification Facility. Actions are being taken to support an effort that promotes modernizing and automating tank farms equipment and infrastructure to further protect tank farms workers from potential exposure to tank vapors and transition the equipment to Operations. Continued analytical support services from the 222-S Laboratory and operational support services from the 242-A Evaporator are required to achieve continued safe operations of the tank farms.

This function includes the following focus areas:

1. Tank Farm Operations – Improve technology related to everyday operations.
2. Vapor Programs – Modernize and automate infrastructure to further protect workers from potential exposure to vapors and general worker protection.
3. Infrastructure Integrity and Upgrades – Improve inspection techniques and upgrade utilities, transfer lines, and support facilities to deliver feed to the WTP.
4. 242-A Evaporator – Upgrade the facility as necessary to support the RPP mission and increase DST space.
5. 222-S Laboratory – Continue support services to continue safe operations of the tank farms.
6. Sampling and Transport – Confirm tank waste is within chemistry control and prepare to feed to the WTP.

Sections 5.1.1 and 5.1.2 include the catalog sheets for funded and unfunded technologies, respectively, that fall under the MTW function.

5.1.1 MTW Catalog Sheets – Funded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

CHIEF TECHNOLOGY OFFICE

washington river protection solutions

DST PRIMARY TANK BOTTOM VOLUMETRIC INSPECTION

HANFORD SITE
US DEPT OF ENERGY

FUNDED

UT inspections have been deployed; however, there is a need to continue to develop the program to establish a more comprehensive volumetric evaluation of the tank bottom floor. More quantitative data is needed to validate tank integrity through inspection of a suspect region where degradation understanding is limited.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

TEDS ID: MTW-11 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Recommended by the High-Level Waste Integrity Assessment Panel in RPP-ASMT-57582, *Second Workshop of the High Level Waste Integrity Assessment Panel, Extent of Conditions and Balance of Program*.

Recommended by Independent Registered Professional Engineer in RPP-RPT-58441, *Double-Shell Tank System Integrity Assessment Report (DSTAR)*, as Recommendation R16-4. Implement advanced ultrasonic testing (UT) techniques at the tank bottom to obtain quantitative data to validate the structural integrity in the bottom region of double-shell tanks (DSTs).

TECHNOLOGY SOLUTION

FY 2019 scope developed selected sensor technologies further to include a delivery system for deploying into the tank annulus and to inspection target location. Following this integration effort, full-scale testing of the system is planned prior to in-tank deployment.

UT technology proposed for WRPS application falls under two categories: piezoelectric UT (shear wave, guided wave, and phased array) and electromagnetic acoustic transducers (EMAT) UT. The piezoelectric transducers are generally smaller and function at high frequencies. The challenge is that they require a couplant, which is often difficult for remote applications. EMAT requires no couplant because sound is generated in the part that is inspected, and EMAT does not require a completely clean test surface. The disadvantages of EMAT are large size transducers and necessary additional signal processing.

Original Guided Wave Phased Array FY 2017

CHIEF TECHNOLOGY OFFICE

washington river protection solutions

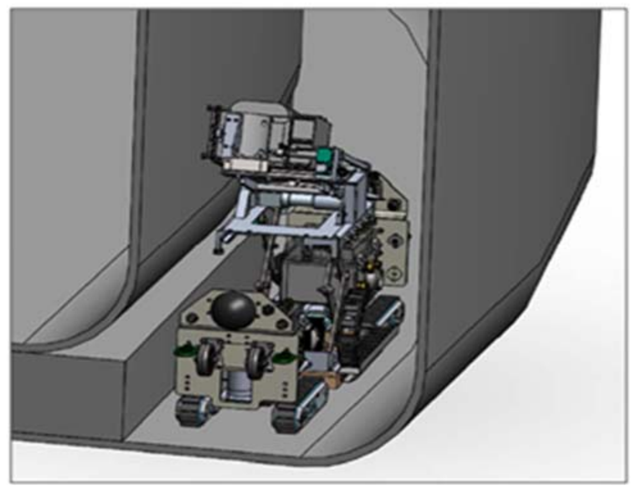
DST PRIMARY TANK BOTTOM VOLUMETRIC INSPECTION

TEDS ID: MTW-11 Continued

ADDITIONAL TECHNICAL INFORMATION

Grand Challenge 2017, Nondestructive Inspection Robot for Monitoring Integrity of the Primary Tank Bottom of DSTs, was precursor to this technology development activity.

Guided Wave



SWRI EMAT Concept

COST AND SCHEDULE SUMMARY

WBS number: 5.01.01.05.20.04

Project or Activity	FY21 Q1	FY21 Q2	FY21 Q3	FY21 Q4	FY22 Q1	FY22 Q2	FY22 Q3	FY22 Q4	Total
Guided wave/Eddify System: vendor adapted equipment qualification, software development, test plate mods and position tracking techniques	□	■	■	■	□	□	□	□	$2,430
Southwest Research Institute : vendor adapted equipment qualification software development, test plate mods	□	■	■	■	□	□	□	□	$515,745
Funding In Thousands (000s) Per Year	$3,011				$0				$3,011

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

washington river protection solutions

TERTIARY LEAK DETECTION & FOUNDATION ROBOTIC INSPECTION

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Ultrasonic thickness inspections of some DST secondary liners have shown localized, reportable thinning ranging between 10% and 70% of the available wall thickness.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: MTW-73 **Priority: High** **Rank: N/A**

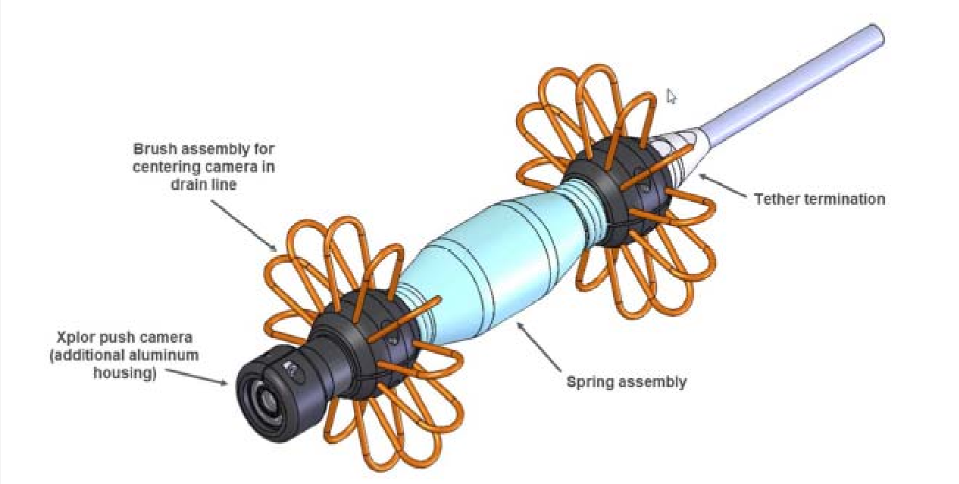
TECHNOLOGY NEED

A drain line crawler deployed in the AN or AW Tank Farms would allow for visual inspection of the underside of a double-shell tank (DST) secondary liner and help determine the condition of the liner.

TECHNOLOGY SOLUTION

In 2013, a crawler was developed and deployed in tank AY-102 to visually investigate the condition of leak detection pit drain line. A similar robotic crawler could be developed for deployment in other DSTs to investigate the condition of the underside of the secondary liner.

Use of a robotic crawler to view the leak detection pit (LDP) drain pipe and concrete foundation would give the clearest indication of moisture presence and the extent of corrosion in the environment below the secondary liner. In the AN and AW Tank Farm tanks, the drain pipe transitions to a single large slot in the foundation slab that provides access to the underside of the secondary liner. This configuration provides an opportunity to inspect the entire radius of the secondary bottom plate both visually and with other volumetric nondestructive examination methods. Better understanding the condition of the secondary liner will help determine mitigation strategies to arrest the threat to the secondary liner.



New Prototype Inspection Tool

CHIEF TECHNOLOGY OFFICE

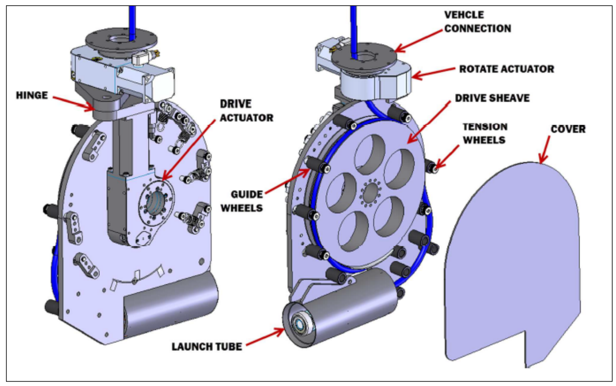
washington river protection solutions

TERTIARY LEAK DETECTION & FOUNDATION ROBOTIC INSPECTION

TEDS ID: MTW-73 Continued

ADDITIONAL TECHNICAL INFORMATION

The inspection tool will be deployed from the VT150VC using a push deployment add-on module consisting of a powered sheave to push the tool into and along the access pipe, coupled to a rotation actuator to allow the tool to be properly aligned to the access pipe for insertion. The inspection tool will be based on the Inuktun Xplor™ push camera system, which includes a fiberglass core tether that can be pushed through the drain line. The Xplor push camera is a fixed focus, non PTZ camera, that is terminated on the end of a fiberglass core tether. The core tether (push rod) will travel through the center of the VT150VC to the motorized push add-on assembly. The push tether consists of a custom layout that includes additional twisted pair conductors to potentially accommodate future NDT or visual inspection tools.



Tertiary Leak Detection System Examination Tool

COST AND SCHEDULE SUMMARY

WBS numbers: 5.01.01.14.2 & 5.01.01.14.3

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Preliminary Design Report – Milestone 1 08 May 2020	■	■	□	□	■	□			$50
Final Design Report – Milestone 2 05 Jun 2020		■	■	□					$100
Fabrication & Assembly Complete – Milestone 3 14 Aug 2020				■					$250
Factory Acceptance Test Complete – Milestone 4 28 Aug 2020				■					$75
Ship System – Milestone 5 11 Sep 2020				■					$25
Site Acceptance Test Complete – Milestone 6 25 Sep 2020					□	□	□	□	$0
Fuding in Thousands (000s) Per Years	$500.00				200 Site acceptance testing deffered unti FY22				$700

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

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LARGE-VOLUME SUPERNATANT SAMPLER & TRANSPORTATION SYSTEM

HANFORD SITE
US DEPT OF ENERGY

FUNDED

A large-volume shielded sampler is needed to take 1 L samples of supernatant to support the direct-feed low-activity waste Radioactive Waste Test Platform. An improved transportation system is also needed to transport the larger samples to the laboratory.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

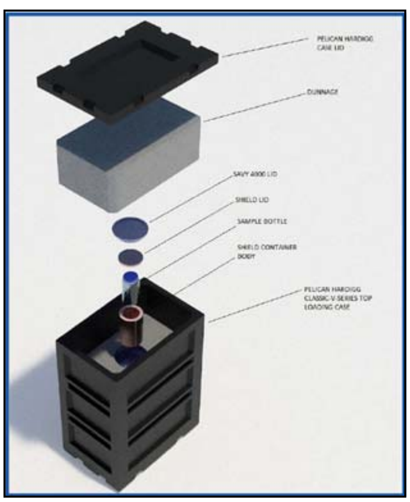
TEDS ID: MTW-77 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

The current tank farms approach to obtaining supernatant samples is to lower a weighted sample bottle on a wire to a required depth and collect a grab sample of 500 mL maximum (typically 250 mL). A large-volume sampler (1 L) is needed to support the River Protection Project mission, while providing improved shielding to reduce worker radiation exposure. An improved transportation system (Hedgehog III) is needed to transport the larger samples to the laboratory for analysis.

TECHNOLOGY SOLUTION

The concepts developed in RPP-RPT-60607, *Sampling and Transportation Study*, are planned to be fully designed and fabricated. After fabrication, shielded sampler testing for functionality and performance is planned. Reviews will be conducted to determine if further engineering is needed. Similarly, the Hedgehog III is planned to be fully designed and fabricated. It is planned to be tested for functionality and certified to comply with DOT 7A Type A package. The Hedgehog III is expected to be reviewed to determine if additional engineering is necessary. The shielded sampler and Hedgehog III are expected to be deployed in the field after testing and reviews.



Hedgehog III Concept Drawing

DOT 7A Containment Box

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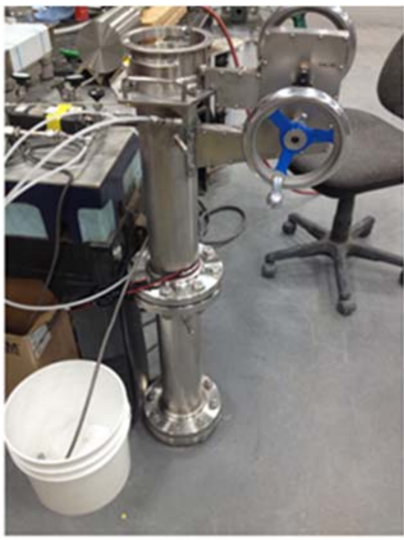
LARGE-VOLUME SUPERNATANT SAMPLER & TRANSPORTATION SYSTEM

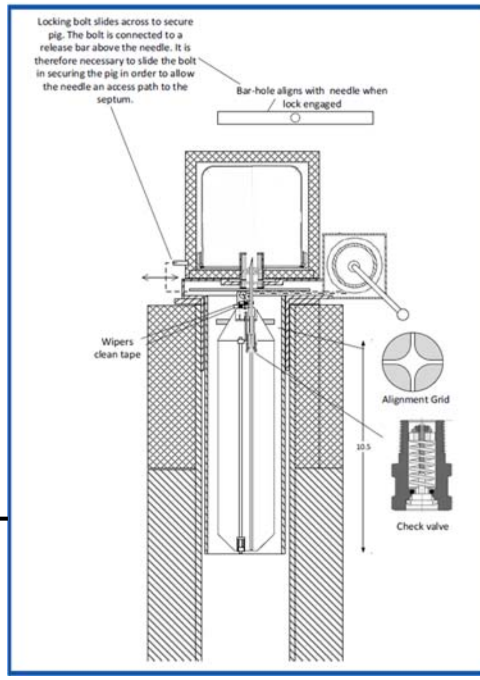
TEDS ID: MTW-77 Continued

ADDITIONAL TECHNICAL INFORMATION



Shielded Sampler

Shielded Sampler Concept Drawing



COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03.13

Shielded Sampler	FY21				Total
	Q1	Q2	Q3	Q4	
Modify Design Based on Lab Input	■	■			$100
Shielded Sampler Fab and Retest		■	■		$323
Shielded Sampler Proof of Concept		■	■		$548
Hedgehog III DOT 7A Certification			■	■	$451
Funnding In Thousands (000s) Per Year	$1,422				

RISKS AND OPPORTUNITIES

Opportunity. Using a smaller sample requires many more sampling events (increasing worker exposure, costs, schedule durations). Successful deployment of the large-volume shielded sampler would reduce all of these things.

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CHIEF TECHNOLOGY OFFICE

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SECONDARY LINER BOTTOM DAMAGE MITIGATION TECHNOLOGIES

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Methods to alter environmental conditions beneath the secondary liner are required. Technology to dry out the under tank environment or otherwise make the environment protective of the carbon steel secondary liner bottom should be developed to ensure long-term availability of the DSTs.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: MTW-83 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Devices or systems to install on existing double-shell tank (DST) systems to cease moisture accumulation in the tertiary leak detection system and foundation space beneath the secondary liner. This technology needs to dry out the foundation space and/or otherwise prevent continued exposure of the secondary liner to corrosive conditions.

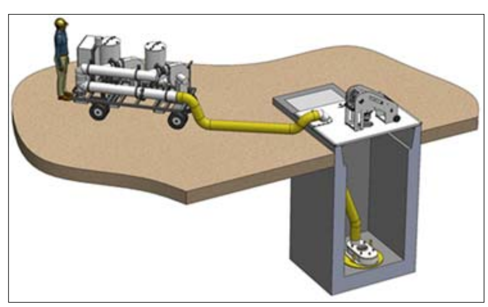
TECHNOLOGY SOLUTION

Initially, plug the cross-tie in tank AZ-102 with a special tool. Pending results, proceed with testing a slight positive pressure on the leak detection pit (LDP). Details in RPP-PLAN-60778, *Double-Shell Tank Tertiary Leak Detection System Investigation and Mitigation Plan.*

Implementing a positive pressure test would encompass the following:

- Install a fan system on the LDP capable of maintaining the tank tertiary atmosphere (i.e., the space between the secondary liner and the concrete foundation/shell) at a slight positive pressure relative to ambient.
- Monitor changes in water intrusion (via a camera on the LDP drain line and/or LDP liquid level).
- Monitor conditions in the LDP (i.e., verify slight positive pressure when the fan is on and slight negative when the fan is off, humidity, temperature).

The scope of this activity is a process test to introduce a positive pressure in a SY Tank Farm tank and monitor the LDP liquid level to see if intrusion inflows are stopped. The test duration would be long enough to verify cessation of intrusion (estimated 3 to 6 months). Results of the test would formulate a basis for project application on the remaining tanks.



Pit Pressurization and Monitoring System

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SECONDARY LINER BOTTOM DAMAGE MITIGATION TECHNOLOGIES

TEDS ID: MTW-83 Continued

ADDITIONAL TECHNICAL INFORMATION

The PASS system consists of centrifugal fans coupled to electric motors and mounted on a mobile platform. The fans combine flow into a single manifold header where the air is then delivered to the LDP via flexible duct hose. Pressure and flow rate measurement instrumentation as well as a weather-hardened electronics enclosure also resides on the mobile platform. The electronics enclosure houses motor control hardware to control fan speeds, and any other electrical hardware required to operate the system. A human-machine interface will be installed on the exterior of the electronics enclosure to allow for local control and readout of the system.

COST AND SCHEDULE SUMMARY

WBS number: 5.1.1.5.50.1

Project or Activity	FY20				FY21				FY22				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
PASS Fabrication and Funtional testing and delivery	■	■	■	■									$700
Field Deployment					□	□	□	□	□	□	□	□	$500
Funding In Thousands (000s) Per Year	$700				$0				$500				$1,200

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

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REAL-TIME LOCALIZED CORROSION MONITOR-PROBE

HANFORD SITE
US DEPT OF ENERGY

FUNDED

NanoCorrTM analyzers were developed on the basis of the coupled multi-electrode array sensor technology patented by a major international research organization, and backed by several other U.S. and international pending patents. They are highly sensitive and reliable for all types of non-uniform corrosions including localized corrosions. They are also the only type of corrosion instruments in the world that have ever been claimed to be quantitative for monitoring localized corrosion below mill-per-year or micron-per-year levels.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: MTW-87 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Currently, no technology is employed to perform real-time monitoring of tank waste for localized corrosion (i.e., pitting) in the double-shell tanks (DSTs) or at the Effluent Treatment Facility (ETF). Development and deployment of such a technology would provide valuable information on the current waste stored in each of the DSTs and if the waste induces localized corrosion. An added benefit of deploying such probes in DSTs would be the ability to monitor changes in corrosion rates due to various tank operations such as waste transfers and chemistry addition to meet the new corrosion control limits. Recommended by the Tank Integrity Expert Panel Corrosion Subgroup.

TECHNOLOGY SOLUTION

Recommend testing the off-the-shelf technology, NanoCorr system, in a laboratory environment using different waste simulants similar to what the probe would be monitoring. This testing was partially performed in FY 2019 and additional testing is being performed for FY 2020. Testing will be performed by DNV GL. Testing will include a stainless steel probe to be used at ETF and a carbon steel probe to be used in the DSTs. Different waste simulants will be prepared to test the probe and determine whether these probes should be recommended for deployment. Field deployment should be evaluated in FY 2020. The feasibility of field deployment is not yet planned, but will likely be in FY 2021 at the earliest.

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REAL-TIME LOCALIZED CORROSION MONITORING PROBE

TEDS ID: MTW-87 Continued

ADDITIONAL TECHNICAL INFORMATION

NanoCorr Data Acquisition System

NanoCorr Tank Corrosion Probes

NanoCorr™ coupled multi-electrode sensor in association with NanoCorr Instruments

COST AND SCHEDULE SUMMARY

WBS number: 5.01.01.05.44.09

Project or Activity	FY20				FY21				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Testing multiple corrosion probes in multiple conditions	■	■	■	■	□	□	□	□	$150
Tank deployment	□	□	□	□	■	■	■	■	$300
Funding in thousands (000s)	$150				$300				$450

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

washington river protection solutions

TANK REPAIR

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Tank repair technologies such as false bottom, magnetic patching and cold spray are currently being evaluated, and cold spray is being considered as a viable candidate for life extension and repair of DOE complex infrastructure (e.g., DSTs) critical to the Office of Environmental Management cleanup mission. Applying cold spray to the DOE complex has the potential to reduce cost and schedule impacts associated with component failures and the need to procure and construct replacement infrastructure.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

TEDS ID: MTW-92 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

A practical repair strategy and method is needed to restore tank integrity by permanently patching and filling pits and cracks or other flaws using various technologies, mitigate leaks to extend double-shell tank (DST) life and ensure existing DSTs can support the River Protection Project timeline. Successful development and use of this technology could help avoid new tank construction.

TECHNOLOGY SOLUTION

Based on the assessment provided in RPP-RPT-62020, a three-pronged technology development approach is recommended:

1. Mature promising, purpose-driven repair technologies (e.g., repairs applicable for very large, tank bottom flaw areas such as that observed in tank 241-AY-102).
2. Develop near-term, high-maturity technologies for expedited deployment in the event of a DST leak.
3. Initiate development of long-term, proactive endeavors that support Hanford mission sustainability, with a focus on the ability to rebuild DST surfaces prior to realizing through-wall penetrations.

In support of this approach, cold spray is one of the first technologies being developed. The concept for a deployable cold spray repair system is focused on making repairs using “like-like” materials. This approach will require determining spray-gun/nozzle geometries and process parameters (e.g., feed rate, standoff distance) for application to flaws and geometries most prevalent at Hanford. Process development will need to determine the process parameters for low-carbon steel powders, to verify that robust hermetic seals with good structural behavior can be generated and for future determination of the geometric limits of the through-wall hole that can be repaired. This initial evaluation will make use of the newly installed PNNL cold spray processing system ½-inch plate. The efficacy of the process will be evaluated in this preliminary study based on the consistency and density of the metallurgic bond and the minimization of volumetric defects. This will be determined primarily through microstructural characterization of the material deposits and interface regions.

CHIEF TECHNOLOGY OFFICE

washington river protection solutions

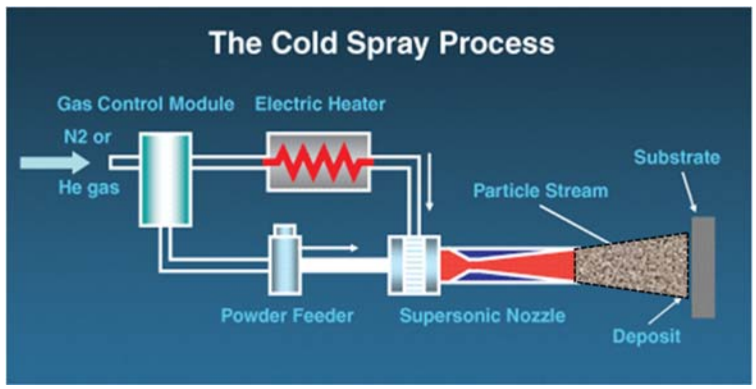
TANK REPAIR

TEDS ID: MTW-92 Continued

ADDITIONAL TECHNICAL INFORMATION

Technology development success will be determined through two stages:

1. At the microscopic level to determine level of bonding and thickness formation (porosity and density) capability and effects of surface preparation, which points to favorable mechanical properties.
2. Process parameter development (FY 2021) to include NDE assessment of a repaired section.



COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03.13

Project or Activity	FY20				FY21				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Phase-1 Mechanical setup and design	■	■	□	□	□	□	□	□	$157
Phase-2 Cold spray process parameter development	■	■	■	■	□	□	□	□	$314
Test process	■	■	■	■	□	□	□	□	$314
Development of deployment method	■	■	■	■	■	■	■	■	$1,415
Funding in thousands (000s)	$1,100				$1,100				$2,200

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0045-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

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CESIUM ONLINE MONITORING FOR TSCR

HANFORD SITE
US DEPT OF ENERGY

FUNDED

The goal of the work is to identify the appropriate COTS gamma detector(s), demonstrate performance under Hanford waste conditions, develop operational protocols for the user process interface and deploy a reliable and robust gamma detection system into the TSCR system and Low-Activity Waste Pretreatment System.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: MTW-93 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Currently proposed cesium detection plans for the tank-side cesium removal (TSCR) system describe two continuous gamma detectors (for redundancy). This relatively simple design requires a lengthy counting period of nominally 1 hour to allow for the ingrowth of Ba-137m, the short-lived daughter of Cs-137 that is detected by gamma spectrometry, to attain secular equilibrium with the parent isotope. This delay is described in the plans as a slow fluid flow piping section with about 300 gallons of volume. This piping section holds the product stream for enough time to allow for 137mBa decay before the gamma level is analyzed downstream. The key design parameters are the vessel volume, dimensions, and baffle layout (see H-14-111252, *General Arrangement Delay Tank,* and *RPP-CALC-62498 –TSCR Delay Tank Sizing*.

TECHNOLOGY SOLUTION

A significant opportunity exists to consider the use of multiple detectors in an integrated feedback system that focuses on neutron radiographic testing (NRT) prediction of the tank AP-106 cesium content, rather than a conservative ion exchange (IX) column cesium breakthrough trigger. Leverage existing staff experience and capabilities at Pacific Northwest National Laboratory (PNNL) in nuclear detection, especially in the area of online process monitoring; a robust near-real-time monitoring solution (resistant to affects from bubbles and other process upsets) can be developed based upon commercial-off-the-shelf (COTS) technologies.

CHIEF TECHNOLOGY OFFICE

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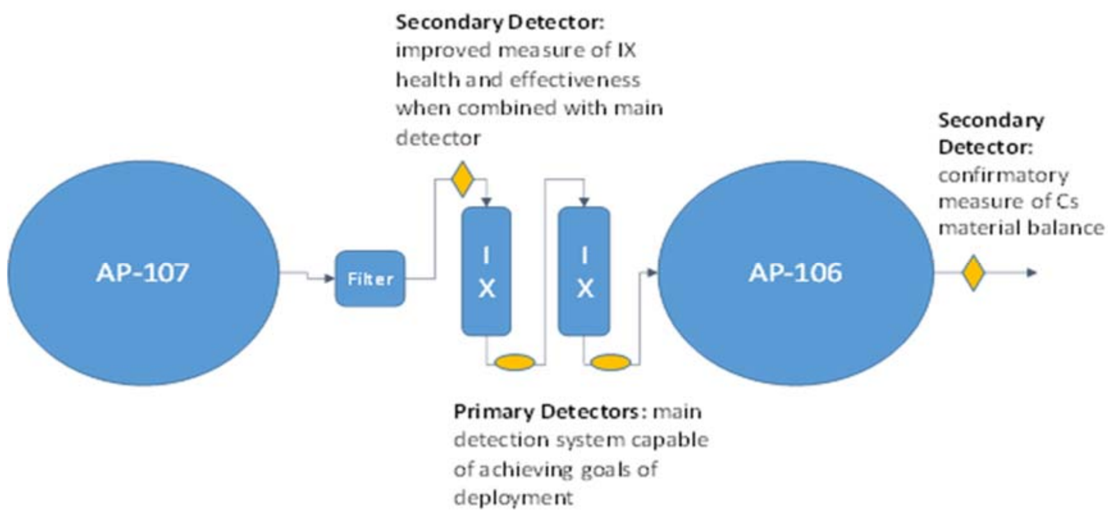
CESIUM ONLINE MONITORING FOR TSCR

TEDS ID: MTW-93 Continued

ADDITIONAL TECHNICAL INFORMATION



Multiple Detectors in an Integrated Feedback System

COST AND SCHEDULE SUMMARY

WBS number: 5.3.12.2.2.5

Project or Activity	FY20				FY21				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Develop model for uncertainty budget	■	■							50
Scale-up for high active solutions	■	■	■	■					453
Evaluate system and analysis for impacts	■	■	■	■					160
Demonstrate addition of confirmatory detector			■	■					105
Demonstrate addition of front end detector			■	■					105
Field deployment/testing/demo			□	■	■	■	■	■	750
Funding in thousands (000s)	$923				$700				$ 1,623

RISKS AND OPPORTUNITIES

Opportunity. Although the TSCR system planned is considered sufficient this technology allows for possibly more utilization of CST by an improved method of detection.

Risk 222SL-0009-T, 222-S Laboratory Analytical Capabilities Are Exceeded

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CHIEF TECHNOLOGY OFFICE

washington river protection solutions

INTERNAL DATA ACCESS & VISUALISATION (IDAV)

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Web-based application that provides IH users with access to historical and current vapor sampling and monitoring data. The application would provide intuitive tools for data analysis, exposure assessments, supporting development of hazard controls.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

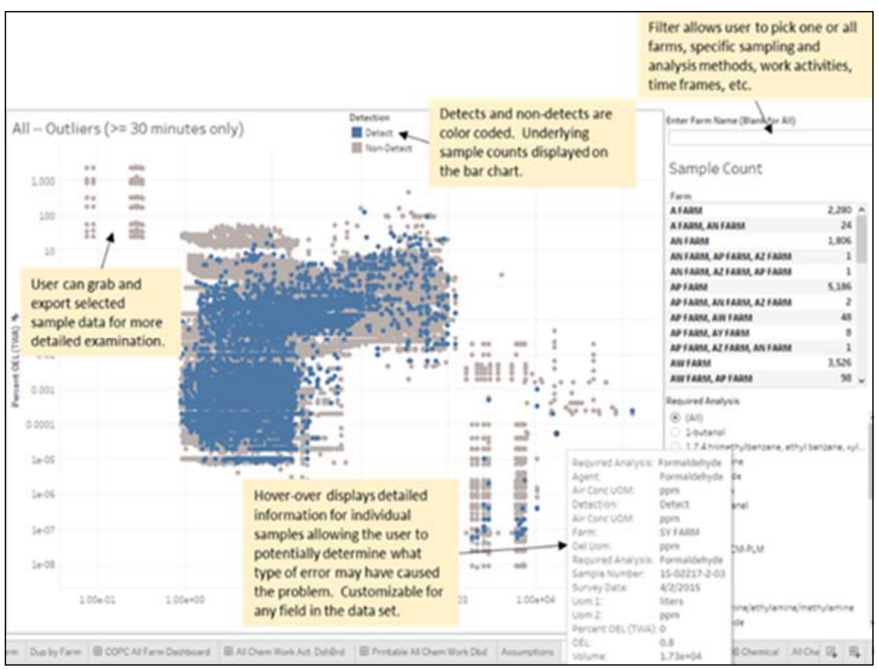
TEDS ID: MTW-94 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Tank Operations Contractor Industrial Hygiene (IH) conducts tank farm worker hazard exposure assessments to identify, evaluate and recommend controls and other worker protection measures for tank farm chemical, physical, and biological hazards. The current IH database, involving tens of thousands of records, is a manual process. The IH vapor data varies widely in its scope and quality, containing errors from sampling and analysis issues, transcription, unit transposition, and inconsistent data collection. IH analysis and exposure assessments are time consuming and human resource intensive.

TECHNOLOGY SOLUTION

Model, build and develop a web-based application that automates IH tank farm worker vapor, chemical and biological exposure assessments, data collection, analysis and visualization processes. The system would provide users with access to historical and current vapor sampling and monitoring results, intuitive tools for data analysis, exposure assessments and IH evaluation supporting development of hazard controls. The system would be automated, providing scalable analysis process, defensible results and improved quality.



Error Detection and Outlier Analysis (Occupational Exposure Limit Basis)

CHIEF TECHNOLOGY OFFICE

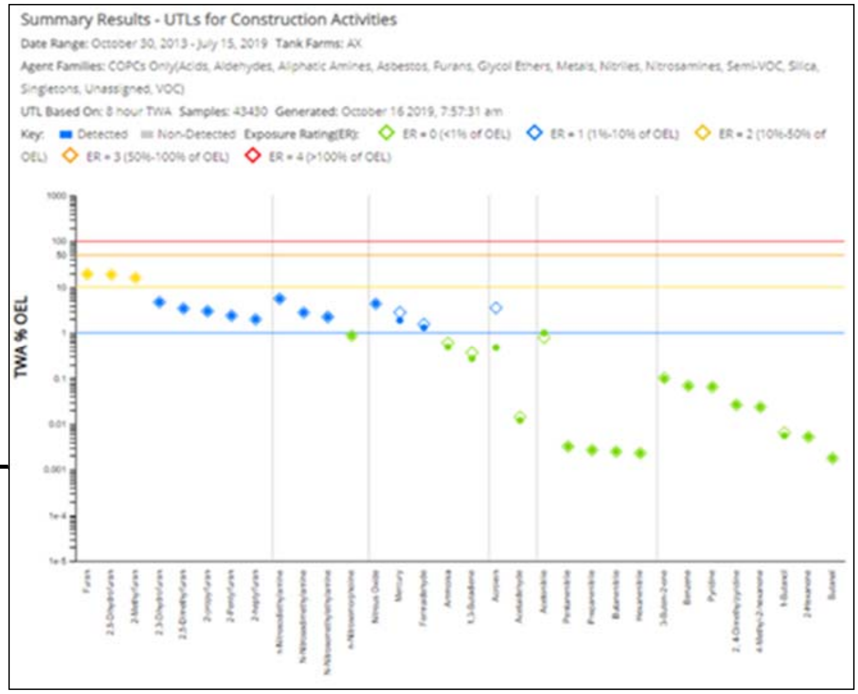
washington river protection solutions

INTERNAL DATA ACCESS & VISUALISATION (IDAV)

TEDS ID: MTW-94 Continued

ADDITIONAL TECHNICAL INFORMATION

Graphical Upper Tolerance Limit Summary Results by Work Activity (Construction in AX Tank Farm)



COST AND SCHEDULE SUMMARY

WBS number: 5.01.05.02.19.17

Project or Activity	FY21				Total
	Q1	Q2	Q3	Q4	
Collect new data Sets , acute and personal ammonia monitors build new modules analyze data for noise submit report	■	■	■	■	$1,300
Funding In Thousands (000s) Per Year	$1,300				$1,300

RISKS AND OPPORTUNITIES

Opportunity to greatly enhance data analysis, conditioning and corrections to the Sitewide Industrial Hygiene Database. Resource optimized analysis of large volumes of data. Tools that enable analysis not previously possible (e.g., health effects of mixtures).

Risk WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

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CHIEF TECHNOLOGY OFFICE

washington river protection solutions

DATA FUSION AND ADVISORY SYSTEM (DFAS)

HANFORD SITE
US DEPT OF ENERGY

FUNDED

The DFAS, powered by the AECOM SmartSite software platform, compiles vast amounts of dynamic data and delivers it in an easily understandable dashboard monitor.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: MTW-95 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Develop an integration of real-time vapor and meteorological data to predict tank farm vapor conditions (i.e., plume location or transient vapor concentrations) in the tank farm work areas. The Data Fusion and Advisory System (DFAS) is 1 of the 15 technologies identified during the Chemical Vapors Solutions Team (CVST) evaluations included the use of a chemical vapor release and response software system to gather and assimilate real-time data from detection/monitoring technologies (new and existing) to predict tank farm vapor-related conditions. A goal of this integrated system is to develop means to predict potential exposure scenarios and establish preemptive mitigating actions.

TECHNOLOGY SOLUTION

The DFAS will be able to correlate data from the multiple vapor sources and other vapor-related instruments, allowing users to study the factors present when the field conditions change in real time. The system will allow Hanford tank farms central shift office staff and field workers to track and trend vapor source data and to potentially predict future vapor source concentrations and weather conditions in work spaces and locations based on historical and real-time field-based data. Dashboard graphics will provide an at-a-glance indications of data to assess current conditions and potential risks. The overall vapor-related risk will be determined by comparing the real-time vapor data (concentration and weather data) to quantitative risk assessment modeling results such as those documented in RPP-RPT-61595, *Vapor Monitoring & Detection System Quantitative Risk Analysis 241-AY and 241-AZ Tank Farms*. This information can be used in conjunction with other vapor indicators (e.g., IH investigation results following reported tank farm fugitive [TFF] odors, ongoing retrieval operations or waste transfer waste-disturbing conditions) to help in vapor event decision making or to predict potentially hazardous vapor conditions and take preemptive actions.

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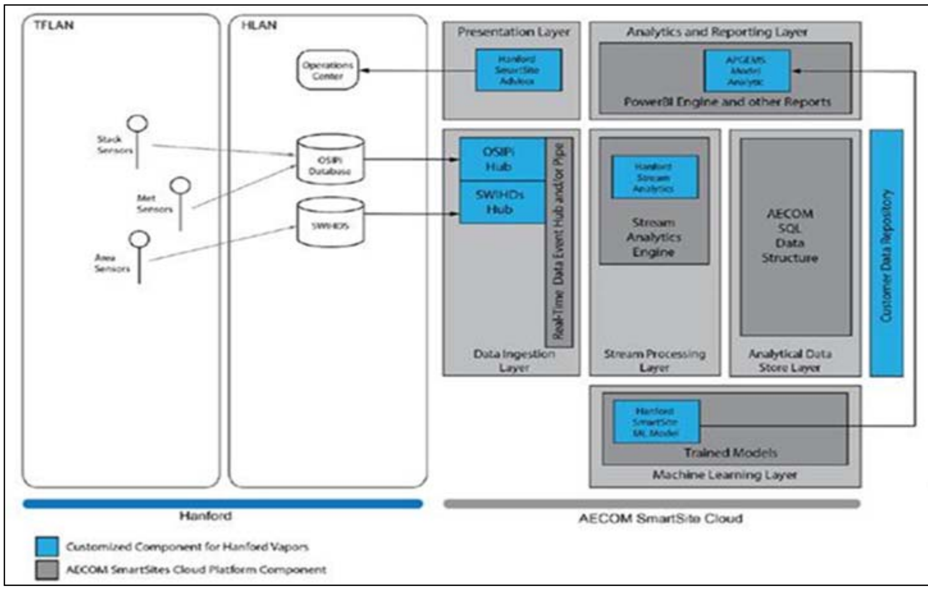
DATA FUSION AND ADVISORY SYSTEM (DFAS)

TEDS ID: MTW-95 Continued

ADDITIONAL TECHNICAL INFORMATION



SmartSite Solution Components

COST AND SCHEDULE SUMMARY

WBS number: TBD

Project or Activity	FY21 Q1	FY21 Q2	FY21 Q3	FY21 Q4	Total
Add a kiosk view and AW and AN stack exhauster data to the DFAS	■	■	■		$450
Evaluate and pilot near real-time plume models in the DFAS			■	■	$384k
Evaluate and pilot DFAS SmartSite software platform for Hanford non-vapor application(s) and implement previously evaluated machine learning application (meteorological data) in the DFAS	■	■	■	■	$966k
Funding In Thousands (000s) Per Year					$1,800

RISKS AND OPPORTUNITIES

Risk WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

Opportunity. The DFAS is used daily by operations and receives data from various sources. This information can be used in conjunction with other vapor indicators to help in vapor event decision making or to predict potentially hazardous conditions and take preemptive action.
Risk: WRPSC-0003-T Tank Vapors Controls Impact Project Execution

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5.1.2 MTW Catalog Sheets – Unfunded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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AUTOMATED DST ANNULUS CAMERA SYSTEM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Develop an automated system that would be permanently mounted to each open annulus riser in order to decrease field entries, increase frequency of visual inspections, and improve inspection repeatability.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

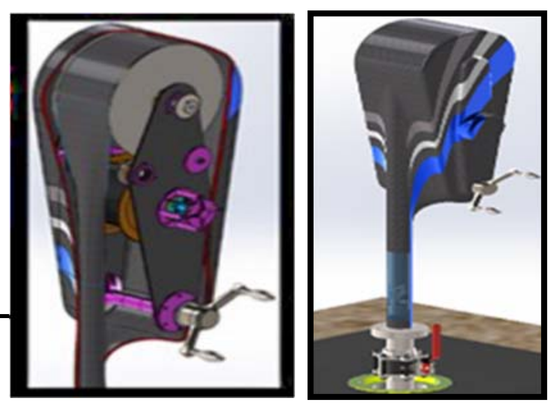
TEDS ID: MTW-09 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

The High-Level Waste Integrity Assessment Panel recommended in its second workshop (RPP-ASMT-57582, *Second Workshop of the High Level Waste Integrity Assessment Panel: Extent of Condition and Balance of Program*) that in order to improve data gathering, WRPS should increase visual observations in the annulus. Annulus visual inspection was the first sign that tank AY-102 leaked. Similarly, visual inspection may be the first sign of another tank leak. In order to provide earlier warning of new or developing leak sites, visual inspections should be conducted more often than every 3 years.

TECHNOLOGY SOLUTION

Automated, permanently mounted camera systems would allow inspections to occur every day, week, or month, as prescribed. Automated systems would also improve the uniformity and quality of video from one inspection to another. That would increase video review efficiency. Worker entries into the tank farms would only be required for maintenance or replacements associated with the cameras. This system is intended to be used on only selected tanks such as tank AY-102 to optimize surveillance of high-risk tanks.



Model of Annulus Camera System

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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CHIEF TECHNOLOGY OFFICE

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PHASED ARRAY UT TESTING IMPLEMENTATION FOR DST WALLS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Advancement of the DST nondestructive examination program through development of a more versatile and capable inspection technology. Faster and more comprehensive inspection of the DST primary tank wall, including welds and heat affected zones, could be realized.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

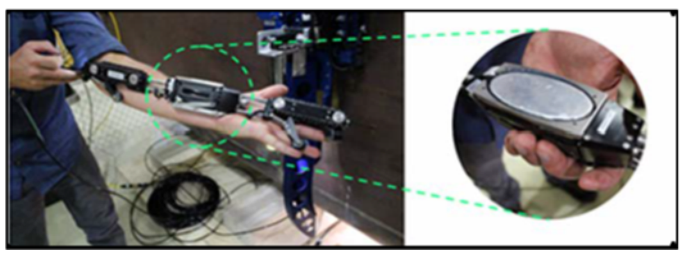
TEDS ID: MTW-10 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

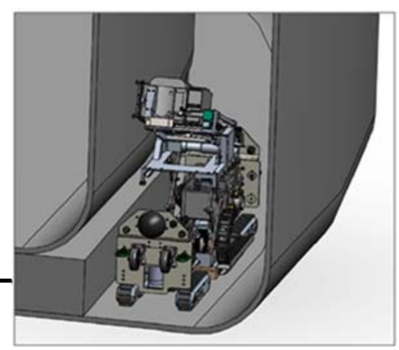
Limited corrosion data for welds and heat-affected zones was identified as a contributing deficiency. Advancement of the double-shell tank (DST) nondestructive examination program through development of a more versatile and capable inspection technology has been identified as a means to correct the deficiency. In doing so, faster and more comprehensive inspection of the DST primary tank wall, including welds and heat-affected zones, could be realized.

TECHNOLOGY SOLUTION

Both South West Research Institute and Guidedwave / Eddify systems have the greatest potential for increasing the examination of the side walls. Both systems are detection systems. Once a flaw is generally detected, normal beam UT can be used to determine approximate dimensions.



Guidedwave Phased Array



SWRI EMAT Concept

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
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IMPROVE LIQUID OBSERVATION WELL DATA ACQUISITION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Measurements of tank interstitial liquid levels are time-intensive and do not occur frequently enough to develop useful level trends. Improved sensor technology and automation would allow for more frequent readings and less time for field crews in the tank farms.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

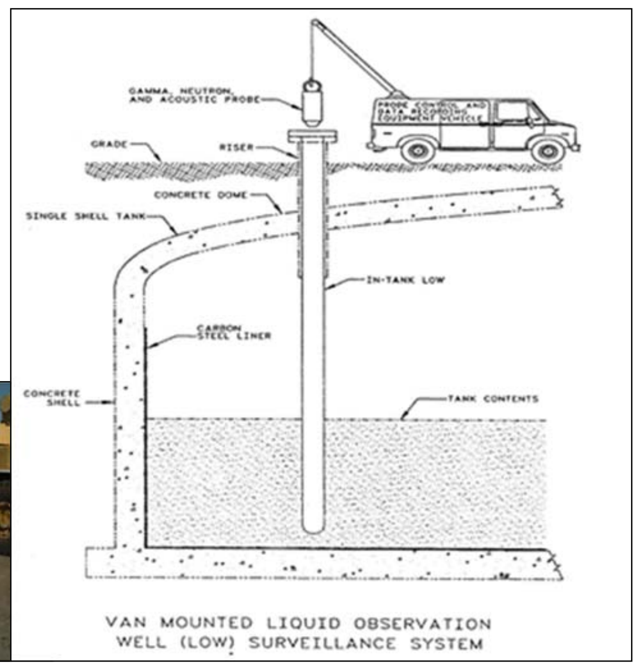
TEDS ID: MTW-13 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Liquid observation well (LOW) scans are currently obtained by a four-person crew in a specially outfitted van. The crew risks exposure to radiation from both the tank waste and the LOW probe source every time they conduct scans. An automated LOW system would reduce worker exposure. LOW readings are obtained approximately 4 times a year; this does not support the amount of trending data needed to detect intrusions or leaks in a timely manner. There has been no research conducted into improved sensor technology, which would allow for easier deployment of an automatic system for obtaining LOW scans. Research is necessary to determine the feasibility of improved technology and automated scanning. Once improved sensor technology has been identified, a system is planned to be designed, built, tested and deployed.

TECHNOLOGY SOLUTION

Research, design, build, test, and install an automated system to measure LOW neutron and gamma in selected single-shell tanks with a program to analyze and trend data coupled to the OSIsoft PI System.



RISKS AND OPPORTUNITIES

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Risk TFIRR-0048-T, SST Failure in West Area

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UPGRADED STILL & VIDEO SYSTEM FOR TANK INSPECTION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Upgrades to the current primary tank video inspection system should include a camera with high-definition resolution, improved lighting, data acquisition equipped with multiple video inputs, updated file formatting and large storage.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: MTW-20 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Current video camera and lighting cannot provide the level of detail required for tank integrity inspection examination of spontaneous chemical processes and other changes that may be occurring. The current visual inspection approach involves using a GE PTZ-140 or PTZ-70 video camera with a supplemental Ahlberg light. An Ahlberg Hi-Rad XS camera is available with 1080p resolution. That is the extent of currently employed radiation-tolerant, small-diameter (less than ~3.7 in.) video camera technology. Data acquisition also needs improvement to provide an updated file format to support greater SD storage including updating the system with an ATEM production system for efficient video switching.

Data Acquisition System

TECHNOLOGY SOLUTION

Identify and test an improved video camera and lighting system, a still photography system, a data acquisition system and a data storage system for tank integrity inspections. The video and still camera systems should, at a minimum, provide:

- Sufficient resolution and lighting to identify down to 1/16-in. cracks in the tank concrete dome using existing risers.
- A reproducible indexing system and ability to be deployed by two people (maximum) without a crane.
- Ability to take high-resolution screenshots or pictures.
- Camera lenses and other components that will survive in high temperatures and radiation fields.

RISKS AND OPPORTUNITIES

Risk TFIRR-0047-T, SST Failure in West Area
Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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VAPOR MONITORING, CHARACTERIZING & REMEDIATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

This technology area supports the development of tank farm vapor monitoring, detection and remediation system technologies (equipment and software).

TEDS ID: MTW-24 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

During work activities, it is desirable to quantify all known vapor sources and fugitive emissions sources and evaluate/investigate observed vapor situations, associated conditions and provide a basis for resolution. The data/information gathered by various equipment in conjunction with dispersion modeling results supports three functional needs, namely providing: (1) a performance-based gas detection system designed to reduce risk by notifying/warning operations staff and workers during a potentially hazardous release event, (2) predictive tools for trending data analysis with dispersion modeling and forecasting events to assist work planning activities and (3) characterization tools to describe tank farm vapor condition. In addition, there is a need to mitigate vapors via destruction and filtration.

TECHNOLOGY SOLUTION

Provide technology development to support the implementation of the recommended tank farm vapor monitoring detection system (VMDS) equipment/software. VMDS technologies include GPS (worker/equipment location); improved chemical and direct reading sensors (fixed/portable); spectroscopy monitors UV-FTIR stack monitor; open OP-FTIR and UV-DOAS area/fence line monitors); NDMA treatment: and whole-air samplers. Modifying the autosampler (continuous effluent monitor) to include real-time (FID, UV-DOAS) and near-real-time (GC-FID) detection capabilities for stack monitoring the additional detection capability will be able to trigger the whole-air grab sampler based on results from these detectors. In addition, the Autosampler is planned to be developed for use in tank farm area monitoring and for headspace sampling/analysis.

AreaRAE Wireless Multi-Gas Monitor

RISKS AND OPPORTUNITIES

Risk WRPSC-0003-T Tank Vapors Controls Impact Project Execution

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

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SLURRY PROPERTY INVESTIGATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Knowledge of tank waste slurries physical properties is critical to waste transfers, waste treatments, effluent management and melter feed operations. Particle size analysis and viscosity are currently investigated. However, slurry properties are needed to ensure waste slurries perform according to current system design pressures.

Technology Maturation Level.
Improve Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-36 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Technology is needed to further understand slurry properties of actual tank waste to investigate particle density, particle settling rates, shear strength, cohesiveness and erosiveness. Currently, needed particle size analyses are obtained by laser interferometry viscosity and shear strength is measured by viscometry. Additional evolution is needed to investigate variations in the methods of particle size determination using instruments other than laser interferometry.

TECHNOLOGY SOLUTION

A new method of particle size analysis should be developed that combines sieving, laser interferometry and the use of hydrometers. Results can be corroborated by scanning electron microscopy, optical microscopy, and x-ray diffraction analyses. The technology development is planned to follow these general steps:

1. Technology review and selection (with National Laboratory).
2. Vendor search.
3. Purchase and installation.
4. Methods development and implementation.

Particle Size Analyzer

X-Ray Microtomography

RISKS AND OPPORTUNITIES

Risk :AAXRC-0011-T Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved

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TANK WASTE CHARACTERIZATION & IDENTIFICATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The 222-S Laboratory employs XRD, scanning electron microscopy, polarized light microscopy and sequential leaching to identify solid phases in tank wastes. Improved instrument capabilities and sample preparation methods are needed to better identify solid and liquid phases in tank wastes and to improve ALARA considerations. PNNL provides some additional capabilities.

Technology Maturation Level.
Laboratory Research and Development

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-37 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Updated and new instrumentation is expected to improve routine analyses of tank wastes, infrastructure (piping, tanks, pumps), vadose zone sediments, as well as analysis of unique samples, to better support the Tank Operations Contractor (TOC) mission. Improved technologies enhance the detection and identification of liquid and solid phases and organics in tank wastes including those with short range order (e.g., nanoparticles). Instrument improvements may also aid waste processing (filtration, pumping, mixing, transfers) and support technology developments for direct-feed low-activity waste and the Low-Activity Waste Pretreatment System.

TECHNOLOGY SOLUTION

The existing x-ray diffraction (XRD) instrument includes minimal measurement and calibration capability. The desired XRD instrument incorporates dual detector technologies, point and area detectors, and multi-mode optical components and associated measurement geometries. The unique combination of these components allows for the unambiguous distinction between trace phases (currently unidentified peaks). The new XRD can also extend solid phase characterization capabilities to identify nanoparticle phases. This instrument will yield data of substantially higher resolution and statistical quality enabling the use of more advanced data analysis methods such as Rietveld refinement.

A complementary Raman micro-spectroscopy is needed to aid the identification of molecular constituents, based on vibrational frequencies of the chemical bonds and bond energies.

FTIR and Infrared Microscope

RISKS AND OPPORTUNITIES

Risk AAXRC-0011-T, Tank Waste Not As Expected (Different than Modeled) – Takes Longer or Cannot Be Retrieved

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IMPROVE SAMPLING METHODS OF HEAD SPACE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Improved methods and instrumentation are needed to measure particle size distributions of head space particulates. Improved instrumentation is also needed to capture, preserve and analyze head space particulates.

Technology Maturation Level.
Deploy & Test Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1-5 Million
2-3 Years

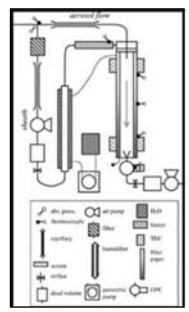
TEDS ID: MTW-40 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

A program is needed to sample and measure head space particulates. Information gathered would help to mitigate exposure risks in the tank farms. Instrumentation is needed to capture, measure, and preserve aerosolized tank constituents for laboratory analyses. In addition, laminar-flow hood capabilities would be essential to laboratory analyses of particulates.

TECHNOLOGY SOLUTION

Head space sampling methods and instrumentation need to be improved to capture and preserve head space particulates. Deploying cloud condensation nuclei (CCN) technology to measure particle size distributions of head space particulates before and after waste-disturbing activities would enable better estimation of the magnitude of particulate generation during these activities. Impactor technology can be deployed to capture head space particulates. Impactors may also be coupled to CCN instrumentation for real time measurement of particle size distributions prior to particulate capture. This program would design and assemble measuring and sampling (CCN and impactor) technologies for improved understanding of particulate generation to help mitigate personnel exposure risks in the tank farms.



Flow Schematic

Cloud Condensation Nuclei Counter

Cascade Impactor with Multiple Impact Plates

RISKS AND OPPORTUNITIES

Risk WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

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ANALYTICAL METHOD DEVELOPMENT FOR CHEMICALS OF CONCERN

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Analytical methods need to be developed, standard reference materials are needed and new instrumentation is needed to facilitate addition of COCs to the list of calibrated compounds.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: MTW-41 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

The 222-S Laboratory is required to develop methods or improve detection limits for dozens of analytes for the Chemical Vapors Program and for the direct-feed low-activity waste feed qualification. The list of chemicals of concern (COCs) contains many chemicals for which there are no qualified (calibrated) analytical detection procedures. Developing new analytical methods is very time consuming and resources must be balanced against ongoing industrial hygiene analytical needs. Some compounds are never developed into calibrated procedures due to failing quality criteria too frequently or failing to pass method validation studies. Current analytical capabilities do not meet COC reporting limit needs for several compounds. Further investigation is needed to identify and adopt method improvements. Analytical conditions need to be determined for compounds where significant new separations are needed, new sampling or trapping media, or new instrumentation is needed.

TECHNOLOGY SOLUTION

Analytical method development requires more funding:

1. For staff to identify alternative sources of standard reference materials.
2. To purchase new sampling or trapping media.
3. For staff time to develop new analytical methods.
4. To test and evaluate alternative analytical methods when more appropriate than gas chromatography-mass spectrometry (GC-MS).
5. To coordinate supportive National Laboratory efforts.

High-Pressure Liquid Chromatography Instrument

RISKS AND OPPORTUNITIES

Risk 22SL-0009-T, 222-S Laboratory Analytical Capabilities are Exceeded.

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CHIEF TECHNOLOGY OFFICE

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RETRIEVAL SUPPORT SYSTEM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Development of a retrieval support system which can add capacity for use in continued SST waste retrieval missions and risk reductions of aging tanks. New tank capacity would be used to safely store, stage, transfer and potentially treat retrieved waste as applicable.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$5-$10 Million
4 Years

TEDS ID: MTW-50 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Currently, single-shell tank (SST) waste retrieval activities require an existing double-shell tank to serve as a waste receiver tank. Existing double-shell tank space is limited and is expected to become even more before the Waste Treatment and Immobilization Plant (WTP) begins processing waste. Development of new tank capacity specific to waste retrieval can provide a means to allow continued risk reduction through retrievals and also can provide an opportunity for treatment of the waste prior to transfer.

TECHNOLOGY SOLUTION

Development of this type of tank system is a multi-phase activity. Initial efforts are expected to focus on developing permitting, design, procurement, and construction strategies based on retrieval-specific needs. After strategy development, execution would follow a typical project life cycle with a tailored approach.

Examples of equipment may include: instrumentation, process equipment, and treatment systems with vapor abatement. A staging tank system could also provide the technology required to transfer retrieved waste to WTP feed double-shell tanks from single-shell tank farms located in remote areas.

RISKS AND OPPORTUNITIES

Risk TFIRR-0046-T, DST Failure in West Area
Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0048-T, SST Failure in West Area

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PREDICTING BEHAVIOR OF MERCURY IN EMF

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Operating data from the 242-A Evaporator campaigns is used to predict operations in the Effluent Management Facility (EMF) evaporator. The behavior/impact of the higher mercury concentration on the new evaporator is not known.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 years

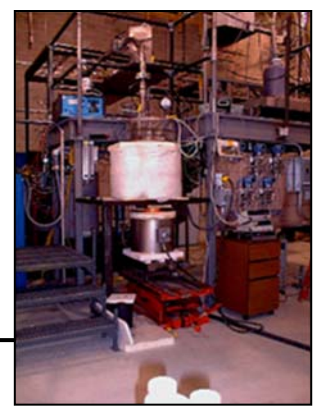
TEDS ID: MTW-57 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Partitioning of mercury in low-activity waste (LAW) melter off-gas processes, wet electrostatic precipitator (WESP), and submerged bed scrubber (SBS), has not been experimentally determined. Data from laboratory-scale venturi scrubber testing was used to estimate the decontamination factor for the SBS; LAW off-gas processes were assigned a decontamination factor of one. An accurate decontamination factor for mercury in the LAW off-gas system is needed to determine the mercury concentrations of LAW condensate. Furthermore, the Hanford Tank Waste Operating System does not track mercury in the SBS/WESP off-gas condensate recycle. During direct-feed LAW (DFLAW), the mercury concentration is needed to accurately assess the impact on tank farm and the evaporator.

TECHNOLOGY SOLUTION

The approach is to update the assumed partitioning for mercury in the process models to allow better estimates for the condensate during DFLAW operations. Key considerations during the testing will include validation of $HgCl_2$ as the mercury species in the LAW off gas, followed by small-scale and/or large-scale tests to determine mercury partitioning in the SBS and WESP. An assessment of the improved mercury partitioning on the remaining LAW off gas processes are planned to be performed and used to evaluate the impacts of the expected mercury levels during processing in the 242-A Evaporator.



Engineering-Scale Evaporator

RISKS AND OPPORTUNITIES

Risk ETFOP-0059-T, Secondary Waste Form Uncertainty

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HIGH SILICA (ZEOLITE)-CONTAINING PPE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Implementation of commercial large-pore high-silica zeolites (HS series) in personal protective equipment for the removal of nitrosamines from the tank vapors can help protect tank farms personnel by reducing exposure to the hazardous constituents of the tank vapors and address short-term and long-term health concerns.

Technology Maturation Level.
Prototype

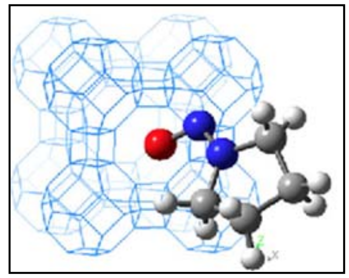
National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-59 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED



The vapor resolution program calls for implementation of methods to anticipate, recognize, evaluate and control chemical hazards associated with ongoing emissions of tank vapors. The tank vapor is a complex mixture of reactive volatile organic chemicals, submicron aerosols, volatile metal and metalloid compounds, and other compounds. Nitrosamines, potential carcinogens, are present in the tank vapors due to the high concentrations of inorganic nitrogen-containing species (e.g., nitrate and nitrite) in the tank waste and their radiolysis degradation products, which readily react with organics in the tank waste. Any tanks or tank farms (e.g., AN Tank Farm) with high organics could contain increased nitrosamine levels.

TECHNOLOGY SOLUTION

Some commercial zeolites have been proven effective at removing nitrosamines from such complex vapor mixtures as tobacco smoke that contains over 5,200 identified chemicals, including several volatile nitrosamines ranging from small common to large nitrosamine derivatives. Zeolites are widely applied in industry as adsorbents and catalysts. It was reported that nitrosamines adsorb on zeolite not only by size/shape exclusion mechanism but mostly by means of the –N–N=O groups entering the zeolite channels similar to the mechanism of NOx adsorption to zeolites (Li et al. 2014, "Cleaning carcinogenic nitrosamines with zeolites"). This specific interaction is responsible for the selective uptake of nitrosamines by zeolites from complex vapors. Further, zeolites can catalytically cleave the –N–N=O functional groups of nitrosamines and destroy their carcinogenic ability.

RISKS AND OPPORTUNITIES

Risk RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due To Controllable Causes

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MOBILE PROTON TRANSFER REACTION—MASS SPECTROMETER

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A PTR-MS mounted in a Mobile Lab is planned to allow for analysis of high-level waste tank vapor concentrations in worker breathing spaces, exhausters, passive breather filters, etc. This will support the vapor management strategy.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: MTW-68 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

A mobile laboratory equipped with state-of-the-art trace gas analyzers is needed to provide the ability to accurately measure chemical of potential concern (COPC) concentrations to 10% of the occupational exposure limit and provide high temporal resolution (2 seconds). Analysis of chemical vapors at trace levels is not possible using available Industrial Hygiene (IH) detectors/instruments. In addition, current IH direct read instruments and off-line samples have low temporal resolution (0.5 minutes to hours).

TECHNOLOGY SOLUTION

Develop and deploy the TerraGraphics Mobile Lab to provide high fidelity ultra-trace gas analysis for COPCs and known odor compounds present on the Hanford Site. Improve the capabilities of the laboratory by installing new instruments to improve speciation for isobaric compounds which the proton transfer reaction—mass spectrometer (PTR-MS) cannot separate and analyze COPC compounds that are currently beyond the capability of the Mobile Lab (e.g., mercury compounds, N_2O). Deploy the Mobile Lab based on IH prioritization of tank farm work evolutions and waste disturbing events.

PTR-MS

- Support IH experiments to decipher between occupational and environmental exposures for COPCs
- Improve understanding of the vapor concentrations in worker breathing zones resulting from normal tank farm operations, including waste-disturbing events
- Characterize and fingerprint fugitive emission sources for attribution during odor events.

Mobile Lab

RISKS AND OPPORTUNITIES

WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

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PLUTONIUM PARTICULATE CRITICALITY SAFETY ISSUE RESOLUTION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Pu-Bi compounds are not included in the inventory of plutonium particulates. They may be large and dense and could be present in the waste in more tanks than previously identified. Studies must be performed to determine the extent and density of Pu-Bi particulates.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

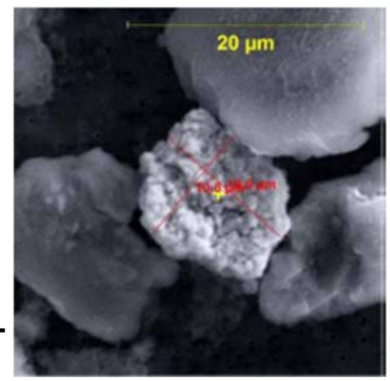
Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
<$1 Million
3-4 Years

TEDS ID: MTW-70 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Criticality safety evaluation is required before waste that holds the larger inventories of particulate plutonium can be retrieved, mixed and transferred. Special concerns arise with the potential that the particulate plutonium-bearing waste in tank SY-102 might need to be retrieved under emergency conditions if that tank starts leaking. Tank SY-102 is one of the more vulnerable double-shell tanks (DSTs) for tank integrity and leakage issues. Retrieval options are limited because it is one of only three DSTs in the 200 West Area. The proposed work is needed to definitively establish the tank farms inventory of particulate plutonium as necessary input to criticality safety evaluation, allowing retrieval of tanks such as DST SY-102.



TEM Image Plutonium Particle

TECHNOLOGY SOLUTION

Two tasks are identified in support of further establishing the particulate plutonium inventory:

- Characterize the particulate plutonium in forms such as PuO_2, Pu-Bi and Pu-Bi-PO_4, determining particle sizes, densities and conditions of formation by advanced laboratory methods, such as transmission electron microscopy (TEM).
- Determine density and conditions of formation of the Pu-Bi compounds by laboratory synthesis to match the TEM analysis. This testing is to understand whether compounds matching those expected to form in the waste can be synthesized under conditions such as in the bismuth phosphate process (i.e., B Plant, T Plant).

RISKS AND OPPORTUNITIES

Risk : TFIRR-0046-T DST Tank Failure In West Area
Risk: TFIRR-0045-T DST Tank Failure In East Area

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IMPROVE BEST-BASIS INVENTORY WITH TWINS DATABASE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Improve the interface used for BBI updates and data access within the TWINS database.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: MTW-71 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Best-basis inventory (BBI) upgrades include:

- Amendment to the existing transfer tool
- Improved update mechanism for volume/evaporation/intrusion updates; development of tools to minimize time spent on non-value -added update tasks
- Module improvement for areas such as vector creation, data review, and statistical analysis.

Suggested Tank Waste Information Network System (TWINS) enhancements include:

- Search functionality
- Automated graphic production
- Simpler application for nonexpert users
- Ability to visualize current and historical BBI data
- Ability to compare inventory or concentrations values for specified analytes or radionuclides including the ability to search sample data by metadata.

For both BBI and TWINS, update to modern computer coding to allow streamlined revision and future upgrades as needed.

TECHNOLOGY SOLUTION

Initiate activity with a study to determine best software platforms and most value-added upgrades based on input from the Tank Waste Characterization Group and other data users. The study should also include a cost-benefit analysis for alternate platforms. Based on this information, a down-selection would occur and a budget and schedule would be developed. A modular approach would be utilized to develop

RISKS AND OPPORTUNITIES

Risk : TFIRR-0046-T DST Tank Failure In West Area
Risk: TFIRR-0045-T DST Tank Failure In East Area

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SELF-DIAGNOSING CONTINUOUS AIR MONITORING

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Provide CAM technology to minimize the need for operations and maintenance personnel to service the equipment during daily rounds.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-72 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Continuous air monitors (CAMs) are inspected during daily surveillance rounds and weekly/biweekly maintenance rounds. This exposes numerous operations, maintenance, and safety personnel to radiation and industrial (self-contained breathing apparatus) hazards. Finding a solution to reduce or eliminate the need for daily surveillance rounds and limiting the number of farm entries for maintenance would reduce worker exposure and improve exposures to as low as reasonably achievable. In addition, the method to analyze, determine, and report on emissions monitoring is time-intensive; having an automated system to analyze emissions would improve worker efficiency.

TECHNOLOGY SOLUTION

The proposed solution would provide the following improvements, at a minimum:

1. Remote indication of CAM operability.
2. Reduce the need for surveillance and service.
3. Real-time indication of whether or not within regulatory emissions requirements.

RISKS AND OPPORTUNITIES

Risk WRPSC-0003-T Tank Vapors Controls Impact Project Execution

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MEASURE BREATHING RATES IN SELECTED SX TANKS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Tank evaporation rate estimates are required when a tank leak assessment is performed. With tanks showing a large liquid loss or very small liquid loss, this has not been a problem but with SX Tank Farm tanks showing liquid losses in the range of 300 to 2,000 gal/yr, the breathing rate needs to be known.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-74 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

The SX Tank Farm tank breathing rates are needed so as to be able to estimate liquid loss rates due to evaporation from those tanks. Without knowing breathing rates, it cannot be concluded whether selected tanks are leaking. The alternative is to state that it cannot be determined whether a tank is leaking or not, which can eventually require a more restrictive means of waste retrieval. The current tank being evaluated, tank SX-104, had leak assessments or evaluations in 1988, 1998, 2008, 2009, and 2011 and is going through another one that began in 2017. The latest leak assessment cannot be completed until this information is available. Leak status of the tanks impact the Tri-Party Agreement milestones and waste retrieval projects.

TECHNOLOGY SOLUTION

Tank breathing rates for 12 tanks in 7 tank farms not including SX Tank Farm were measured in 1997-1998. The rates were measured by injecting inert gases (He and SF_6) into the tank head space, then taking periodic head space gas samples over time to observe the concentration decay. Breathing rates for 10 of 11 tanks excluding A and AX Tank Farms were in a nominal 2 to 3 cfm range, while those for three tanks in A and AX Tank Farms had rates in the 10 to 25 cfm range. One tank in BY Tank Farm was measured at 16 cfm, but it might have been affected by an exhauster used during saltwell pumping. The A and AX Tank Farms tanks are connected by large exhaust header, like those in the SX Tank Farm. These tests need to be performed for SX Tank Farm tanks, with some improvements necessary over the 1997-1998 tests.

RISKS AND OPPORTUNITIES

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SUPER-HYDROPHOBIC METAL SURFACE TO REDUCE EQUIPMENT CONTAMINATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

When equipment contacts tank waste and becomes contaminated, it is difficult to handle and can severely limit engineering design options for waste-contacting equipment. Reducing or eliminating contamination would open up design options and decrease worker exposure.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

TEDS ID: MTW-75 **Priority: High** **Rank: N/A**

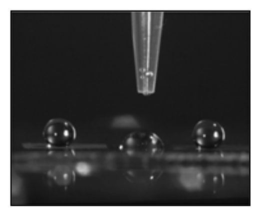
TECHNOLOGY NEED

Any technology that reduces or eliminates equipment contamination reduces the difficulty, time, and expense of dealing with waste-contacting equipment. It also reduces the dose workers receive, a critical as low as reasonably achievable (ALARA) principle. Application of special hydrophobic coatings to metallic equipment surfaces is used in the nuclear industry to reduce contamination. These coatings keep waste from sticking to the equipment, thus reducing contamination. These coatings can only be used in certain applications because they lack durability, lack adhesion to the substrate, or are chemically incompatible with the waste.

TECHNOLOGY SOLUTION

Etching nanostructures using femtosecond or nanosecond lasers creates a hydrophobic surface that is permanent and intrinsic to a metal surface. This new strong hydrophobic property could be applied in a cost-effective manner to small equipment or in-tank instrumentation. The following tasks would assess viability:

Water repelled by laser treated surface



Treated vs non treated (middle) surfaces

1. Verify that laser-treated metal surfaces effectively shed simulated waste.
2. Verify that the treated metal surface is not degraded by waste chemical constituents, exposure to radiation, erosion by insoluble waste particles, reasonable physical impacts.
3. Develop methods to speed application.
4. Apply treatment to a typical piece of waste-contacting equipment, expose to waste, then measure the contamination and compare to unexposed equipment with the treatment.

RISKS AND OPPORTUNITIES

Risk WRPSC-0009-T, Aging TOC Facilities & Infrastructure

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ONLINE MONITORING USING RAMAN SPECTROSCOPY

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Using the Raman spectroscopy, laser-induced breakdown spectroscopy, multi-isotope process method to develop a real-time, online monitoring system of tank wastes.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1-Million
0-2 Years

TEDS ID: MTW-76 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Waste Treatment and Immobilization Plant and direct-feed low-activity waste operations are expected to increase laboratory testing needs for feed qualification sampling, confirmation sampling, and process control. In order to prevent a bottleneck during sample analysis at the laboratory, a technology is needed to shorten the sampling and analysis turnaround time while also maintaining exposures as low as reasonably achievable and increasing frequency of sampling.

TECHNOLOGY SOLUTION

A Raman method is a strong candidate for real-time, online monitoring because sodium salts represent greater than 90% of the supernate. Identification of these analytes using Raman is planned for the next 2 years. Exploring additional online monitoring methods to characterize important tank waste species is also planned.

The Raman method and system will be made of commercially available hardware and chemo-metric analysis software developed at Pacific Northwest National Laboratory. Testing will be carried out on tank waste simulants and real waste samples from the radioactive waste test platform.

The objective of this work is to determine whether this online Raman-based method can meet data quality metrics established for the chemical analytes within Hanford Site tank farms.

RISKS AND OPPORTUNITIES

Risk 222SL-0048-T 222-S Laboratory Analytical Capabilities Are Exceeded (DOE)

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IN-TANK VOLUMETRIC NONDESTRUCTIVE EXAMINATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Development of primary tank bottom volumetric inspection capability addresses a current lack of available data to characterize the potential for degradation of the primary tank bottom within DSTs and single-shell tanks. The product is expected to aid in determining the state of primary tank bottoms using non-visual examination methods.

Technology Maturation Level.
N/A

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: MTW-78 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

An independent High-Level Waste Integrity Assessment Panel performed a review, and one of the issues identified was the inability of the double-shell tank (DST) integrity program to predict the leak; this challenge was highlighted when a leak occurred in tank AY-102. At present, there is no visual or nondestructive examination (NDE) of tank bottoms where the leak occurred in tank AY-102. The method proposed here would supplement the current inspection method under development, which targets DST primary tank bottoms via refractory pad air channels. Inspection through the refractory pad air channels greatly limits the area of the tank bottom that can be reached due to using 24-in. risers for access and obstacles located in the DST annuals space.

TECHNOLOGY SOLUTION

Incorporate a volumetric NDE sensor into either a drill string or push rod for deployment though a riser, through waste, and pressed against the tank bottom. This method would utilize tank risers down to 4 in. in diameter for access to the tank. All other Hanford NDE development restricts access to just the annulus and the under primary tank air channels. Most NDE technologies can easily be fabricated into this size, allowing for the use of several different technologies; each analysis will target a 10-ft-diameter zone for analysis.

NDE Sensor

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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AUTONOMOUS ROBOTIC PLATFORM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Use robotically driven system to autonomously deploy vapor sensors and monitoring detection equipment into the tank farms and demonstrate the ability to download collected information to a central docking station to communicate with the central control room.

Technology Maturation Level.
Modify existing technology

National Laboratory Involvement?
N0

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: MTW-79 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Use autonomous instrumented vehicles to reduce entries into the tank farms while collecting vapor-related data in the worker breathing zone, reducing potential exposure to the workers.

TECHNOLOGY SOLUTION

Procure an autonomously driven device already on the market and configure the instrument deployment with select vapor-related sensors. Demonstrate operation of autonomous instrumented vehicle, monitoring and collecting of data, and wireless transmission of data to a central computing system in order to scale up capabilities. Achieve the Phase I near-term goals in FY 2018:

- Manual and automated control
- Ammonia monitoring
- Visual inspections.

Future phases will build on Phase I to further enhance worker safety and productivity by integrating additional mission needs of the company.

WRPS Rover

RISKS AND OPPORTUNITIES

Opportunities include increased worker endurance, lower strain-related accidents, lower long-term worker health costs from SCBA usage.

Risk WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

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AUTOMATED VISUAL RECOGNITION WIRELESS REMOTE VIDEO MONITORING

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Develop and test a four-camera system with automated visual recognition to monitor a variety of manual gauges, indicators, alarm and status panel boards, and/or sump levels that can automatically recognize visual trigger events and generate alerts. Integrate the associated software into an automated Site-specific system.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-80 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Hanford Site tank farms contain a variety of workplace hazards, including those associated with chemical vapors emitted from the underground waste storage tanks. DOE workplace regulations specify that contractors must establish procedures to identify existing and potential workplace hazards and to assess the risk of associated worker injury and illness. One effective method to control such hazards is to reduce the time spent in the tank farm environment through the use of automated, remote control systems.

TECHNOLOGY SOLUTION

Remote wireless video has been successfully demonstrated and used for various applications at the Savannah River Site, using existing site wireless and wired network infrastructure. The video is displayed in real-time at a nearby or remote monitoring location (e.g., a facility control room), reducing the need for a worker entry to hazardous areas. A similar system specifically tailored to Hanford Site needs can provide a fully automated and easily retrofittable monitoring system to minimize the potential for worker exposure to potential vapors.

Camera Monitor

RISKS AND OPPORTUNITIES

Risk WRPSC-0003-T, Tank Vapors Controls Impact Project Execution

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RADIATION-TOLERANT MULTI-USE MANIPULATOR SYSTEM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Viable technology for in-service Inspection of the Hanford DSTs is crucial to development and maintenance of an effective aging management regime. The snake-arm is a mobile, highly flexible, modular inspection and repair technology. The snake-arm is a proven and viable technology to enable inspections using visual and other NDE techniques.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

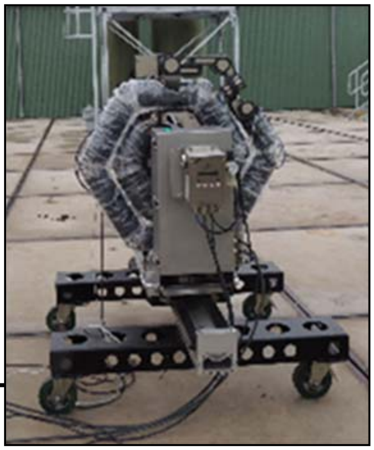
TEDS ID: MTW-81 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

The complexity of the double-shell tank (DST) configurations is such that many of the structural elements and features of most concern to engineers and inspectors are located in inaccessible, hard to reach areas (e.g., DST annulus). In addition, the radiochemical conditions in the tanks are hazardous, ruling out manual access techniques. There is a pressing and immediate need for proven, robust and radiation tolerant remote systems to access the tanks to deploy cameras and other nondestructive examination (NDE) instrumentation to remotely inspect ion and gather data on the tank condition. The overall goal of this project is to demonstrate the use of a commercially available, radiation tolerant, multi-use manipulator system for repairing inspection tasks on the Hanford single-shell tanks and DSTs.

TECHNOLOGY SOLUTION

It is proposed that a proof-of-concept prototype snake-arm system be developed and demonstrated on a mock-up test facility at engineering scale. The test facility will mimic the operating environment in tanks, annulus and air channels based on input from ORP and the Waste Treatment and Immobilization Plant (WTP).



Prototype Snake-Arm

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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PIPLINE FORENSIC INSPECTION TECHNOLOGY

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Several pipelines have failed an encasement pressure integrity test. The Hanford Fitness for Service program has no readily deployable solutions to inspect and identify pipeline failure mechanism locations. A tool to travel through a pipeline and provide a condition assessment is needed to expand current understanding of pipeline failure phenomenon.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

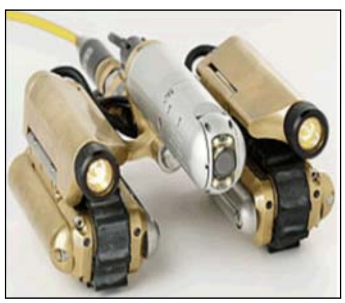
TEDS ID: MTW-84 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Visual and volumetric inspection capability delivered remotely through 2-in. and 3-in. schedule 40 waste transfer lines in the tank farms is needed.

TECHNOLOGY SOLUTION

The proposed technology solution will enter a waste transfer line via a nozzle penetration of a pit. The device would be either self-propelled with a lightweight tether or driven from a push-pull system with a more rigid tether. The end of this inspection tool would be comprised of a visual inspection camera with pan/tilt functionality and lighting adjustment. Future iterations of the tool could include volumetric inspection sensors such as an eddy current probe or guided wave ultrasonic transducers.



Versatrax 100 for Inspection of Small Pipe and Ducts

Self-Propelled Pipe Crawler with Camera Attachment

RISKS AND OPPORTUNITIES

Risk TFIRR-0034-T, SN-622 Failure
Risk TFIRR-0035-T, SN-634 Failure
Risk TFIRR-0036-T, SN-635 Failure
Risk TFIRR-0037-T, SN-633 Failure
Risk TFIRR-0038-T, SN-630 Failure
Risk TFIRR-0039-T, SN-632 Failure

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REMOTE PROFILOMETRY USE FOR SURFACE EXAMINATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Surface profilometry is a commercially available technique used to extract topographical data from a surface. This can be a single point, a line scan or a full three-dimensional scan. The purpose of profilometry is to get surface morphology, step heights and surface roughness.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: MTW-85 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Improved non-contact inspection methods that expand facility integrity knowledge are of high interest. Current noncontact methods deployed are limited to various visual inspection camera systems. Expansion of the inspection toolset to include a system such as compact laser profilometry system would allow better characterization of surface topography at target inspection locations. Possible applications for such a technology includes the concrete dome and liner wall of single-shell tanks, the region above the liquid surface within double-shell tank primary containment and the annulus of double-shell tanks. Use in these environments would provide additional understanding not currently possible with a camera, including size and depth for observed surface anomalies.

TECHNOLOGY SOLUTION

Profilometry inspection tools excel at fast, quantitative surface measurements of tank integrity. In order to use laser inspection tools, modification of a commercial tool would be required to allow for remote deployment and operation within target hazardous environments. Some testing of the systems capabilities would also be required to demonstrate performance expectations.

Compact Laser Profilometry System

RISKS AND OPPORTUNITIES

Opportunity – Increased and improved inspection methods will expand understanding of the facility condition and further characterize the risk of degradation or future failures.

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PROTECTIVE MEASURES FOR WASTE TRANSFER SYSTEM LINES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Design an application of active systems to control encasement environmental conditions and prevent humidity and moisture accumulation are needed.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: MTW-86 **Priority: Low** **Rank: N/A**

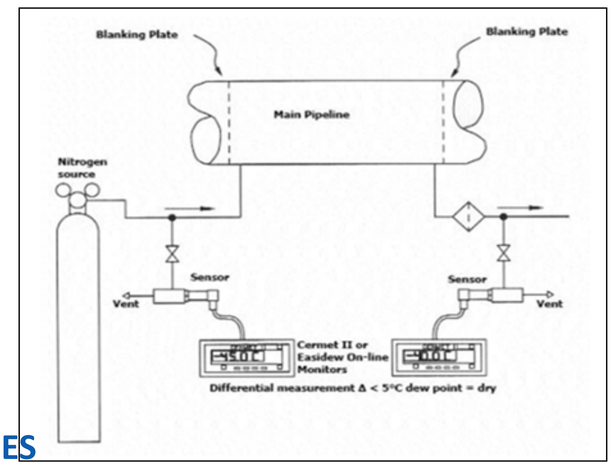
TECHNOLOGY NEED

With the increase in number of transfers scheduled to support the startup of direct-feed low-activity waste (DFLAW) operations, further measures will need to be taken to ensure the integrity of the waste transfer lines. Transfer lines failures could cause schedule delays, resulting in large amounts spending to correct the problem.

TECHNOLOGY SOLUTION

Recent visual inspections from within transfer line test risers have shown various degrees of moisture presence and corrosion. In the case of several lines, the primary pipe or encasement have been discovered as failed via periodic encasement pressure testing. Design of these systems and leak detection practices have the potential to foster a corrosive condition within the encasement of the transfer lines by way of their atmospheric venting and drainage. Nitrogen purge drying is a viable option for preventing moisture accumulation in the annulus of the transfer lines.

Example Nitrogen Pipeline Purge Drying System



RISKS AND OPPORTUNITIES

Risk TFIRR-0034-T, SN-622 Failure Risk TFIRR-0035-T, SN-634 Failure
Risk TFIRR-0036-T, SN-635 Failure Risk TFIRR-0037-T, SN-633 Failure
Risk TFIRR-0038-T, SN-630 Failure Risk TFIRR-0039-T, SN-632 Failure

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LIQUID AIR INTERFACE SAMPLER

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Design and fabricate an interface sampler for use in Hanford tanks to identify the interface with an accuracy of ±1 in. After identification, the device will be able to obtain samples at interfaces. It will be designed to retrieve a 250 ml sample and to fit inside a 4-in. riser located at the top of the tank. The design will comply with ASTM standards and various codes/standards.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-88 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Due to the high ratio of insoluble materials to liquid within a tank, settling will naturally occur. Some materials that do not settle to the bottom of the tank float to the top. There are concerns that organics floating on the surface can lead to an increased risk of pitting at the liquid-air interface. Available Hanford liquid sampling technology cannot detect liquid interfaces nor successfully sample the surface of the liquid, and the depth accuracy is generally limited to about a few inches. A new way to sample liquid-air interfaces and liquid-liquid interfaces is needed.

TECHNOLOGY SOLUTION

A device needs to be able to fit a container through a 4-in. riser with 250 ml. The optimal device would be cylindrical to allow for a large surface area coverage but still be able to fit in the riser used for acquisition of samples. The objective is to keep fluid at the surface from being displaced and disrupted to allow for an accurate surface sample of the fluid. The top of the sampler is to be threaded to fit a regular 250ml bottle so that new transportation does not need to be created. The bottom of the sampler is to be a cylinder for large surface-to-volume ratio. The top of the device can be other shapes or a smaller diameter like a funnel. A funnel design is desirable because it would allow use of a plug to seal the top portion of the cylinder and keep the radioactive waste inside the container with a pour spout for testing in one unit. A closing hatch or door is needed to allow for an open bottom to acquire the sample without disturbing the fluid and causing turbulent flow into the fluid.

Interface Sampler Concept

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T, DST Failure in East Area
Risk TFIRR-0046-T, DST Failure in West Area

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REMOTE CONCRETE SURFACE CLEANING APPARATUS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A remotely operated cleaning tool for concrete walls, waste transfer pits, ceiling cover blocks that are required to be painted with a SPC. This device must be able to thoroughly clean the SPC (i.e., Amerlock® 2/400 resin) without damaging it.

Technology Maturation Level.
Research and concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-89 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

A technology is needed to allow for remote cleaning of concrete walls, waste transfer pits and ceiling cover blocks that are painted with a special protective coating (SPC). Per WAC-173-303, SPC is required for concrete surfaces that may come in contact with tank waste (e.g., tanks vaults process pits, valve pits) must be inspected and repaired as necessary to maintain RCRA permit compliance. These surfaces will get dirty and contaminated due to occasional spills during operations. Before proper inspection and repair can occur the surfaces to be cleaned. Due to high radiation fields noted in most pits, the work associated with the cleaning and required coating repairs must be completed remotely (through the use of extension poles). Inspection of the cleaned and repaired surfaces is completed by visual inspection of high quality digital photographs.

TECHNOLOGY SOLUTION

The DST Annulus Floor Cleaning System, developed by Rolls-Royce for use by WRPS, is a remote operated cleaning tool designed to vacuum debris in DSTs annulus. It is believed that this technology could be further modified to be used in transfer pits and other RCRA facility locations to perform the necessary cleaning.

Typical Transfer Pit Configuration, Areas That Need to be Cleaned

Robotic Cleaner with Vacuum

RISKS AND OPPORTUNITIES

Risk TFIRR-0054-T Pit Corrosion

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WATER/WASTE VOLUME MEASUREMENT FOR 242-A C-A-1 VESSEL

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Technology is needed to determine the water (condensate) level in the reboiler or water/waste level in the C-A-1 vessel. Ideally this device would mount to the tank exterior (on the sides). The technology solution must not degrade tank integrity.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

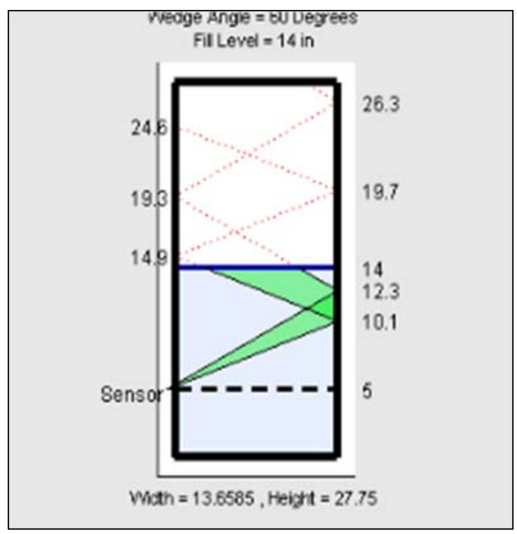
TEDS ID: MTW-90 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Existing instrumentation for monitoring liquid level is antiquated and unreliable; therefore, the need exists to develop a new approach.

TECHNOLOGY SOLUTION

The single transducer employs either multiple piezoelectric elements or mechanical impactors to generate acoustic burst signals with transverse or oblique propagation paths. The transverse propagation path is directly across the tank at the height of the transducer location. The time-of-flight of this echo depends mainly upon the transverse distance (vessel diameter), the liquid temperature and the acoustic properties of the liquid. The estimation algorithm relies on the markedly larger echoes that return from the corner reflectors formed at the interface of the liquid surface and the tank sidewalls. A unique feature in this estimation is the self-calibration provided by the transverse burst traveling a path of known length. Primary features of this volume measurement device include: external mounting at single point, automated calibration for composition and temperature, accurate and precise fill level predictions insensitive to surface foams and crusts, refined fill-level predictions and fill-level trend prediction via Kalman Filter methods.



Signal Schematic

RISKS AND OPPORTUNITIES

Risk 242AE-0001-R, 242-A Aging Facility and Equipment Requires Unplanned Repair or Unanticipated Upgrades

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TANK-SIDE WASTE EVAPORATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A modular, transportable, evaporative system that minimizes risks associated with significant losses of existing 242-A evaporative capacity. Development and deployment plans to use a commercial thin-film evaporator technology modified for nuclear applications. The new WFE could support other potential future missions.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes 2017 GC to buy back-up Mobile Evaporator

Rough Order of Magnitude Cost & Duration?
$1-5 Million
2-3 Years

TEDS ID: MTW-91 **Priority: Low** **Rank: N/A**

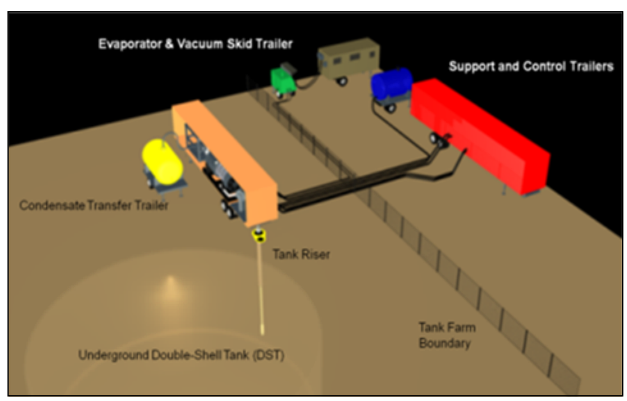
TECHNOLOGY NEED

Additional tank farm waste evaporative capability is needed to mitigate 242-A Evaporator failure risk, provide additional 242-A evaporation capacity, and supply new evaporative capacity to retrieve single-shell tank waste and secondary liquid waste from treatment processes. The proposed technology for this scope is a mobile wiped film evaporator system, relocatable to applicable tank farms. Key development scope involves use of a pilot-scale system to develop the technology followed by use of a full-scale system to validate scale-up of the system.

TECHNOLOGY SOLUTION

The wiped film evaporator (WFE) process uses a horizontal shell encased in a heating jacket. Within the horizontal shell is a rotor with blades that maintain a thin film on the shell wall where energy is transferred from the heating jacket promoting evaporation. The liquid moves horizontally through the shell and is continuously concentrated as volatile components are vaporized leaving non-volatile components that are discharged vertically through the bottom of the WFE. Vapor is discharged vertically through the top of WFE. The WFE shell system is operated under a vacuum allowing the system to perform at a lower temperature, reducing the amount of sensible energy to be transferred.

WFE Test Platform



Proposed Field Location

RISKS AND OPPORTUNITIES

Risk 242AE-0001-R, 242-A Aging Facility and Equipment Requires Unplanned Repair or Unanticipated Upgrades

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EXOSKELETON

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Exoskeleton is an intelligent, battery powered, lower-body support system, capable of transferring heavy loads, such as air bottles, from the spine to the support system. May prevent slips, trips, and falls by maintaining balance.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-96 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

Technology is needed to enhance worker capabilities, allowing safer and more efficient work. Tank farm workers experience repetitive movements, such as going up and down stairs and lifting heavy objects. Technology is needed to enable work to be less tiring and dangerous. Tank farm workers, including firefighters, must regularly wear air bottles, such as self-contained breathing apparatus (SCBA) racks or heavy packs. These heavy loads place a lot of strain on the body's spine, especially when crouching, kneeling or carrying heavy loads. Transferring heavy loads from the spine to the exoskeleton could protect tank farm workers from the strain of added weight, from such equipment as SCBA systems.

TECHNOLOGY SOLUTION

The exoskeleton is a battery-powered, lower-body exoskeleton fitted with artificial intelligence (AI). It is designed to augment human strength and endurance by taking stress off the lower back and legs. It provides additional leg support for physically demanding tasks. The system provides support for the lower body, reducing the burden on a user's knees and leg muscles. The technology makes it easier to perform intensive activities. The exoskeleton AI reads exoskeleton sensors to determine how a user is moving. Actuators then apply torque to the user's knee joints to support their movements. This results in less muscle strain and more endurance.

Exoskeleton Supporting Tank Farm Worker Wearing SCBA

Tank Farm Worker Calibrating Exoskeleton

RISKS AND OPPORTUNITIES

Opportunity – Enhance worker capabilities, allowing safer and more efficient work. Technology will enable work to be less tiring and dangerous.

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CONTINUED NEED FOR IMPROVING TOOLS FOR TANK FARM PROJECTS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Hand-held, self-positioning laser scanning system that includes scanner, computer, 3D printer, and software. Capable of 3D scanning (colors and surfaces) and printing of real-life objects.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-97 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Technology is needed to shorten the time needed to make onsite tools. Significant production time is required to fabricate custom tools for tank farm use. Human errors are experienced with the current manual field measurements and data transfer.

TECHNOLOGY SOLUTION

A three-dimensional (3D) laser scanner can reduce custom tool engineering, design, production/fabrication time for tank farm custom tools. Laser scanning reduces the manual development process of creating a 3D model of the field condition. Field scanning and data transmission reduces human errors experienced with manual data collection and transfer. Hand-held 3D scanners are light weight, mobile, and can be used anywhere to ensure a smooth information capturing process without manual field measurements or having to relocate objects to a particular place for data gathering. Laser 3D scanning reduces human errors. It is a simple point and shoot system that takes precise measurements in high resolution, resulting in 3D output. Selection of a commercially available model that can be modified to use on the Hanford Site is the proposed solution.

Hand-Held 3D Laser Scanner

RISKS AND OPPORTUNITIES

Opportunity to reduce custom tool fabrication for tank farm use.

Risk WRPSC-0011-T, Unexpected Field Conditions Encountered

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LONG REACH ROBOTIC TOOL FOR TANK FARM PITS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A programmable robotic type of mechanical arm, with similar functions to a human arm that would enable remote manipulation of tank farm equipment.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

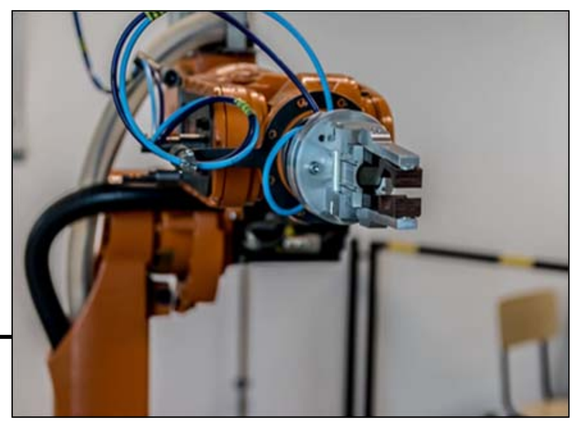
TEDS ID: MTW-98 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Tank farms operations need remote operational support to reduce worker exposures to hazardous conditions and confined space hazards. Tank farms needs remotely operated robotic to perform operational and maintenance tasks such as valve manipulation, welding, surveys, etc.

TECHNOLOGY SOLUTION

A programmable robotic type of mechanical arm, with similar functions to a human arm, would enable remote manipulation of tank farm equipment, such as valves. Robotic tool could be fitted with multiple end effectors for the performance of various tasks. A mobile robotic tool provides the flexibility for use throughout the tank farms.



Robotic Arm

RISKS AND OPPORTUNITIES

Risk WRPSC-0002-T Resources Not Available When Required

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TANK FARM SMART OPERATING PROCEDURES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The existing Tank Farm Operations support software, eSOMS, would be either upgraded or replaced to include all operating procedures. The system will be "smart", enabling tank farms operators to automatically record and enter readings obtained during the performance of operating procedures.

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MTW-99 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Tank farms operators record measurements by using the Rounds process as identified in relevant tank farm procedures. The eSOMS software, also known as E-Rounds, facilitates automated process at the tank farms. The current tank farm operating process is comprised of both a mobile application (rounds application) and a web application, the latter of which is accessed through a desktop browser. This system is partially automated and does not include all operating procedures. Operators automatically record and manually enter readings from some of their procedure rounds, saving time when compared with paper Rounds. However, the system needs to be fully automated to include automatic entry of readings from the operator rounds for all operating procedures. This improve efficiency and also reduce errors associated with manual transfer of data and information.

TECHNOLOGY SOLUTION

A fully automated "smart" procedure system would enable efficient tank farms operations. The current E-Rounds would be upgraded or replaced with a smart system that includes all operating procedures. The automated system would be accessed via portable computers/tablets. With the automated smart system, tank farms operators would complete all procedures electronically as procedures are performed in the field. The electronic system would walk operators through each procedure step, not allowing the operator to proceed to the next step until the previous step is completed. Human errors attributed to manual data entries would be eliminated. The electronic data would be easier to store, retrieve, generate reports from and support near-real-time monitoring at the tank farms.

RISKS AND OPPORTUNITIES

Risk: WRPSC-0010-T Complex Integration of Field Work

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CHIEF TECHNOLOGY OFFICE

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INCREASED NDE VOLUMETRIC INSPECTION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

FT uses an illumination source that induces a temperature rise at the inspection surface, generally in the form of an impulse (high-intensity pulse). Changes in material property can cause a change thermal indication which can be read by an infrared camera

Technology Maturation Level.
Modifying Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

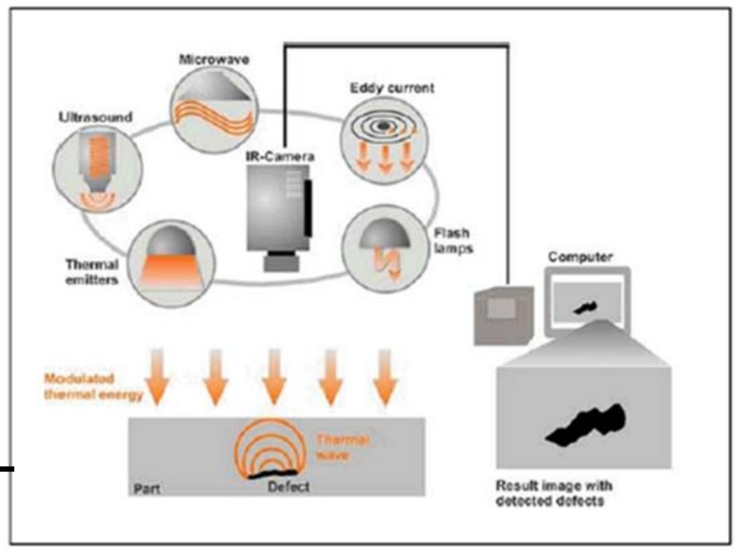
TEDS ID: MTW-100 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

There is a need to develop nondestructive examination (NDE) systems to increase the volumetric NDE of the aging Hanford tanks. Current systems only inspect about 2% of the double-shell tanks (DSTs). This amount was deemed acceptable when general corrosion was thought to be the primary means of degradation. Localized corrosion is now the mode degradation thought most prevalent. As such, the inspection regime needs to extended to a great extent of the tank.

TECHNOLOGY SOLUTION

Numerous technologies may be available for this need. They could include use of flash thermography (FT), guided UT waves, Electromagnetic Acoustic Transducers and others. A limited technology evaluation of FT was conducted, but was found in need of further development because of deployment issues. Should these issue be addressed the technology would provide an adequate solution. As such, FT along with other candidates should be explored to improve the understanding of DST integrity.



FT System Elements

RISKS AND OPPORTUNITIES

TFIRR-0045-T, DST Failure in East Area
TFIRR-0046-T, DST Failure in West Area
TFIRR-0048-T, SST Failure in West Area

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5.2 Retrieve Tank Waste

The waste retrieval function is required to remove most of the waste to close the tanks per regulatory requirements. Retrieval efficiency is based on knowledge of the tank contents for the extraction of the waste with effective tools, the transfers downstream, and the mixing and blending for delivery of feed to the WTP that meets waste form qualification requirements. Across all aspects of the waste retrieval process, there is a need-to-know overall waste composition and chemical and physical characteristics. Remote in situ monitoring of these parameters would enhance and improve retrieval operations. The waste retrieval function can also include special processes such as those envisioned for contact-handled transuranic (CH-TRU) waste and mitigation of selected DSTs.

The various methods of waste retrieval are described in RPP-RPT-44139, *Nuclear Waste Tank Retrieval Technology Review and Roadmap*. Modified sluicing or salt cake dissolution is typically used to retrieve the majority of the waste volume from the SSTs; however, these methods are typically insufficient to reach the established residual waste volume goal of 360 ft^3 or less for 100-series SSTs, and 30 ft^3 or less for 200-series SSTs as mandated by the Tri-Party Agreement. This residual waste is typically characterized as a hard heel of insoluble material that requires more aggressive methods to mobilize and remove from the tank. The TOC also uses mechanical and chemical technologies for hard heel removal subsequent to waste retrieval operations using modified sluicing.

Implementing these technologies can require tank modifications in the form of new and or larger tank penetrations to accommodate waste retrieval equipment. The RTW function includes the following focus areas:

1. Retrievals – Characterization of the SST waste is a first step in successful mobilization and retrieval of the tank waste. Multiple techniques are required to mobilize and retrieve the SST waste to the level needed for ultimate closure of tanks.
2. DST Transfers – The DST waste transfer system is a critical, interdependent system within the RPP that relies on the ability to continually retrieve, treat (as necessary), and transfer tank waste to the LAW Pretreatment System (LAWPS), WTP, and various waste treatment facilities. The near-term DST waste transfer strategy focuses on startup, commissioning, and initial operation of LAWPS, waste volume management, and modeling of waste blending and staging strategies.
3. Cross-Site Transfers – Important technology considerations for cross-site transfer lines are leak detection, line plugging detection and clearing capability, and critical velocity measurement.
4. DST Upgrades – A primary objective of DST upgrades is to ensure that the Hanford Site tank farms are able to provide optimized, continuous, and reliable feed to the WTP or new supplemental treatment systems.
5. Feed Preparation – The primary goal of feed preparation is to ensure that qualified waste feed batches are readily available for WTP and secondary treatment system campaigns.
6. Tank Closures – The ultimate RPP mission goal is to close the waste tanks and associated waste management areas.

Sections 5.2.1 and 5.2.2 include the catalog sheets for the funded and unfunded technologies, respectively, that fall under the RTW function.

5.2.1 RTW Catalog Sheets – Funded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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RETRIEVAL AND CLOSURE SOLID WASTE SAMPLING TOOLS

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Develop, design, build or modify solid waste sampling tools such as the existing ORSS and the extended finger trap.

TEDS ID: RTW-01 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Improved tank waste sampling tools are necessary for the following:

1. Verification of tank closure standards.
2. Simulant development for testing new retrieval technologies.
3. Development of technologies targeted to specific tank waste retrievals.

Current sampling technologies do not fully address the aforementioned needs due to tank access limitations and inability to collect representative samples.

TECHNOLOGY SOLUTION

The first technology development effort involves modification of the existing off-riser sampling system (ORSS) to address inadequacies based on previous deployments. The second effort involves locating a replacement for the current ORSS. The first two efforts are currently unfunded. The third effort involves modification of an existing design to collect solids known as the finger trap sampler. Modification includes lengthening the sample chamber and improving the deployment to include off-riser capability.

Core Sampling Device

Manual Hammer Finger Trap Sampler

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

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RETRIEVAL AND CLOSURE SOLID WASTE SAMPLING TOOLS

TEDS ID: RTW-01 Continued

ADDITIONAL TECHNICAL INFORMATION

Reference: RPP-18793, *Performance Specification for the Off-Riser Sampling System (ORSS)*

Replacement ORSS Option – Deep Trekker DT340

Current ORSS – General Electric Inspection Technology (GEIT) V3020-6310 Crawler and V9500-4001 Sample Scoop

COST AND SCHEDULE SUMMARY

ORSS modification work is currently unfunded with a ROM of $200k over 1 year. ORSS replacement is currently unfunded with a ROM of $500k over 1 year. The funded work is shown below with WBS number: 5.02.01.02.01.

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
CR-001, 002, 003, Sampling Tool Feasibility Study	□	□	□	■	□	□	□	□	$50
C-301 Direct Push Sampler	□	■	■	■	□	□	□	□	$320
CR-011 Sampling Tool System Development	□	□	□	□	■	■	■	■	$820
Funnding In Thousands (000s) Per Year		$75	$145	$230	$80	$260	$290	$110	$1,190

RISKS AND OPPORTUNITIES

Risk AAXRC-0011-T Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved

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RESIDUAL VOLUME MEASURING SYSTEM (RVMS)

HANFORD SITE
US DEPT OF ENERGY

FUNDED

The previous RVMS that the Tank Operations Contractor used was limited by the size of the system (12-in. risers only). The current system was recently deployed for deployment in a 6-in. riser. Smaller technology is needed to access the more available 4-in. risers on single-shell tanks.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: RTW-02 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Accessibility to 12-in. risers is limited; therefore, a smaller residual volume measuring system (RVMS) is needed to access the 4-in. risers that are more accessible. In addition, the integrity and shape of the tank walls and floors is important for tank waste retrieval and closure. More than one access port is needed to attain an accurate tank scan due to obstructions.

TECHNOLOGY SOLUTION

Technology development has been completed. A system evaluation will be conducted for deployment in 4-in. risers.

RVMS Prototype Laser Scanner

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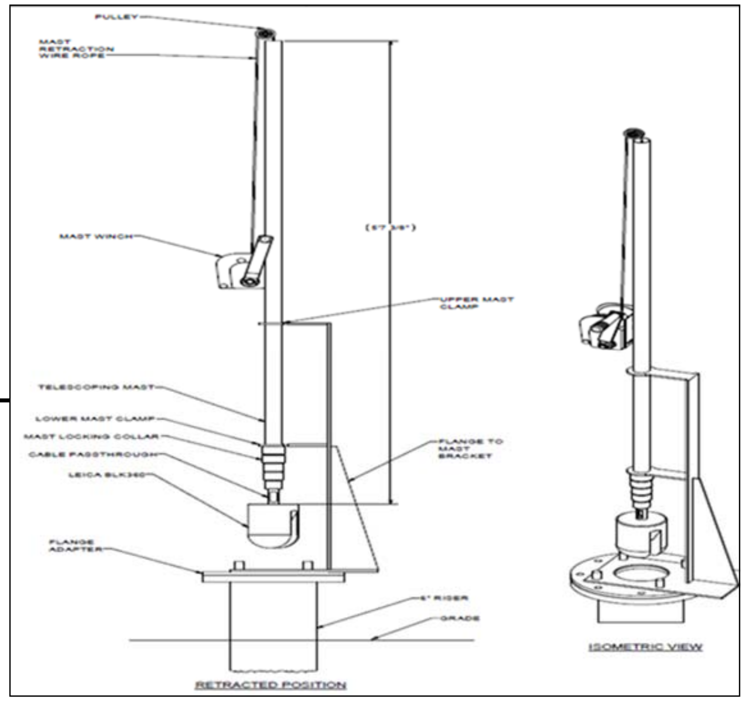
RESIDUAL VOLUME MEASURING SYSTEM (RVMS)

TEDS ID: RTW-02 Continued

ADDITIONAL TECHNICAL INFORMATION

Laser Scanner Installation



COST AND SCHEDULE SUMMARY

WBS number: 5.02.01.02.10.01

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
System Evaluation - 6" riser	■	■	■	■	□	□	□	□	$219
System Evaluation - 4" riser	□	□	□	□	■	■	■	■	$50
Funnding In Thousands (000s) Per Year	$219				$50				$269

RISKS AND OPPORTUNITIES

Risk AAXRC-051-R, Equipment in Risers is more difficult to remove than anticipated

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DRY SLUDGE RETRIEVAL SYSTEM

HANFORD SITE
US DEPT OF ENERGY

FUNDED

A dry sludge retrieval system is needed for hard packed wastes in leaking SSTs. An alternative retrieval technology is needed by 2022 to begin supporting waste retrievals from A and AX Tank Farms.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

TEDS ID: RTW-08 **Priority: High** **Rank: N/A**

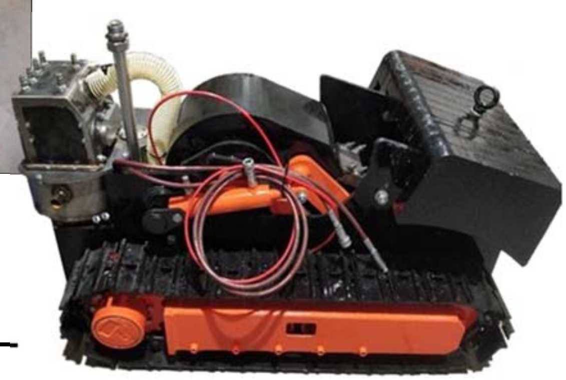
TECHNOLOGY NEED

A technology is needed for retrieving solids from Hanford Site tanks that contain primarily solids (sludge, salt cake, and hard pan). An alternative retrieval technology is needed by 2022 to begin supporting waste retrievals from A and AX Tank Farms. In many single-shell tanks (SSTs), it is undesirable to use sluicing liquids to break up and remove waste due to the known or suspected reduced integrity of the tanks.

TECHNOLOGY SOLUTION

The mechanical waste gathering system (MWGS) originating from a 2017 Grand Challenge proposal is designed to remove hard-packed wastes in tanks using no introduced liquids. A prototype of the waste removal device and transportation system was developed as part of the Grand Challenge. Atkins and Barrnon Ltd. have developed many innovative remote solutions to waste retrieval problems at the Sellafield nuclear complex and at commercial nuclear reactor sites in the UK. The MWGS system leverages industry knowledge and experience allowing an integrated system to be tested and delivered for turnover to retrievals in FY20. With National Laboratory support, dry waste simulants were developed for testing.

3 Passes on 7:1 Mix Concrete



Phase III MWGS

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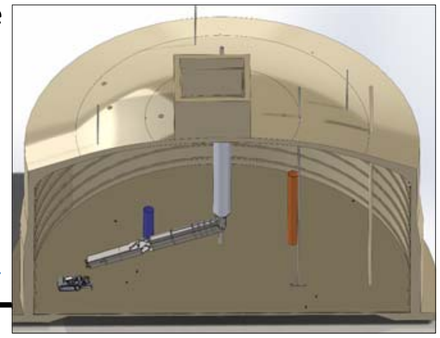
DRY SLUDGE RETRIEVAL SYSTEM

ADDITIONAL TECHNICAL INFORMATION

TEDS ID: RTW-08 Continued

To date, the Tank Operations Contractor (TOC) has utilized modified sluicing, enhanced sluicing, extended reach sluicing system, salt cake dissolution, and the vacuum-mode mobile arm retrieval system. Each process requires addition of liquids to the tanks for heavy sludge and hard cake removal. The hard-packed waste can be granular like sand, hardened rock-like materials (chunks), or a mixture of the sandy material with clay and the hardened chunks. Additionally, several of these tanks have very high radioactive dose rates (~24,000 R/hr total beta, at the surface of the waste). The next series of tanks to be retrieved include those known to have leaked. Although the liquid portion (supernatant/slurry) is no longer present and leaving a heavy sludge, hard cake or salt cake to be retrieved, reintroduction of liquids into the tanks presents environmental issues.



Model of MWGS Deployment

References:

BAR-MWGS-DB3b-001, 2019, *Mechanical Waste Gathering System: Phase 3b Design & Build Report*, Rev. 3

RPP-RPT-61606, 2019, *Integrated Mechanical Waste Gathering System Design and Manufacture for Alternative Retrieval of Hanford Tank Waste*, Rev. 0

ORP Grand Challenge Proposal, 2017, Vitali, J., *Waste Gathering System for Removing Hard Packed Wastes in Suspected "Leaker" SSTs Using No Introduced Liquids*

COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03.17

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Phase IIIc - Integrated System Testing	■	■	■	■	□	□	□	□	$3,700
Phase IIId - Integrated System Testing	□	□	□	□	■	■	■	■	$2,500
Funnding In Thousands (000s) Per Year	$925	$925	$925	$925	$625	$625	$625	$625	$6,200

RISKS AND OPPORTUNITIES

AAXRC-0012-T Delays in A-104 and A-105 Retrieval Due to Technology Development

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DEVELOPMENT OF NEW RISER INSTALLATION SYSTEM

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Technology for drilling multiple enlarged tank holes for risers up to 6 ft in diameter is in the planning phase. Research, design and development of the cutting system will ensure the dome cores are removed utilizing governing safety criteria. Factory and onsite acceptance testing will be performed prior to deployment of a final system.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: RTW-12 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

The goal of this work is to develop a method that is safer for tank farm personnel, is more efficient, and is more cost-effective to implement than previous core cutting efforts. In addition, hard to access risers and pits no longer need to be used for retrieval (e.g., tank C-105). The rotary core cutting system will provide the more efficient method to install a riser in support of tank waste retrieval. The installation will minimize the need to remove existing equipment and allow installation of additional access for other new retrieval equipment.

TECHNOLOGY SOLUTION

The new Riser Installation System is a mobile rotary core drilling system. It cuts through existing soil cover and single-shell tank (SST) concrete domes enabling installation of new SST risers (<60-in. diameter). Development and testing is to be performed by a commercial vendor. Based on successful development and testing, a prototype system is planned to be designed, fabricated and delivered to the Hanford Site for final testing and deployment.

Mobile Rotary Core Driller

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DEVELOPMENT OF NEW RISER INSTALLATION SYSTEM

TEDS ID: RTW-12 Continued

ADDITIONAL TECHNICAL INFORMATION

The A and AX Tank Farm tanks are the next planned to be retrieved. Obstructions in these tanks make waste retrieval challenging. In addition to normal piping, pumps, other components and materials left in the tank, the tanks were designed with air lift circulators (pipes extending from the dome to the bottom of the tanks) that present congestion for retrieval efforts, camera observation, and lighting.

55 in. Diameter Prototype Rotary Core Cutter

COST AND SCHEDULE SUMMARY

WBS number: 5.2.1.2.1.10

Project or Activity	FY20				FY21				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Procure equipment/materials	■	■	■	□	□	□	□	□	$1,040
Conceptual drawings/calcs	□	■	□	□	□	□	□	□	$156
Proof of principle testing	□	□	■	□	□	□	□	□	$169
Design and results report	□	□	■	□	□	□	□	□	$70
Initial testing	□	□	□	■	■	□	□	□	$670
Perform secondary testing	□	□	□	□	■	□	□	□	$280
Testing results report	□	□	□	□	□	■	□	□	$215
Funding in thousands (000s)	$1,835				$765				$2,600

RISKS AND OPPORTUNITIES

Risk AAXRC-0043-T Equipment in Risers is more difficult to remove than anticipated

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5.2.2 RTW Catalog Sheets – Unfunded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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REMOTE TANK FARM ABOVE GROUND INSPECTIONS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Existing technology could be modified to safely inspect the tank farms remotely. Examples include drones with attached cameras and cable-mounted cameras.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: RTW-03 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

During construction and retrieval operations, tank farm inspections are required, creating radiation exposure and other safety hazards for personnel. Personal protective equipment required for vapor safety, such as self-contained breathing apparatus, has created other worker safety issues. Additionally, the time and cost associated with manned entries is significant. The ability to conduct remote monitoring, from the Operations control trailer, would be beneficial. Ideas for remote field inspection include: drones, static-mounted cameras, mobile wire-mounted cameras and remote operated vehicles.

TECHNOLOGY SOLUTION

Subject matter experts shall search for available solutions using the Expression of Interest (EOI) process. Ideas for remote field inspection include drones, static-mounted cameras, mobile wire-mounted cameras, remote-operated vehicles, or in-farm testing.

Drone with Onboard Camera

Magnetic Mounted Camera

RISKS AND OPPORTUNITIES

Risk WRPSC-0011-T Unexpected Field Conditions Encountered

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PROTOTYPE BETA DETECTION PROBE DESIGNED FOR SOIL CONTAMINATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Characterization of contaminated soil is a step to the remediation and closure of tank farm waste management areas. A prototype beta detection probe designed for in-situ detection of beta-emitting soil contamination would be helpful.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: RTW-04 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

Appendix I of the Tri-Party Agreement requires characterization of contaminated soil as a step toward the remediation and closure of tank farm waste management areas. One of the most important risk contributors in soil is technetium-99, a beta emitter. Current methods for identifying technetium-99 contamination involve removing soil samples and performing laboratory analysis. In situ identification can reduce cost and time associated with soil characterization in all tank farms.

TECHNOLOGY SOLUTION

One option under consideration is a prototype that has been previously designed for deployment with a direct-push unit. A survey of other potential methods will be conducted. A down-selected technology will be configured and deployed in coordination with the other soil characterizations.

Direct-Push Prototype Beta Detection Probe

RISKS AND OPPORTUNITIES

More readily support facility closure activities.

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POST WASTE RETRIEVAL UPDATES TO WMA C PA MAINTENANCE

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US DEPT OF ENERGY

UNFUNDED

Identify areas where new information or technology maturation will provide the greatest future benefit (e.g., altered retrieval requirements, affected closure cap design). Information will be integrated into Rev. 1 of the WMA C PA and into the assessments being developed for other WMA closures.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
4+ Years

TEDS ID: RTW-07 **Priority: Medium** **Rank: N/A**

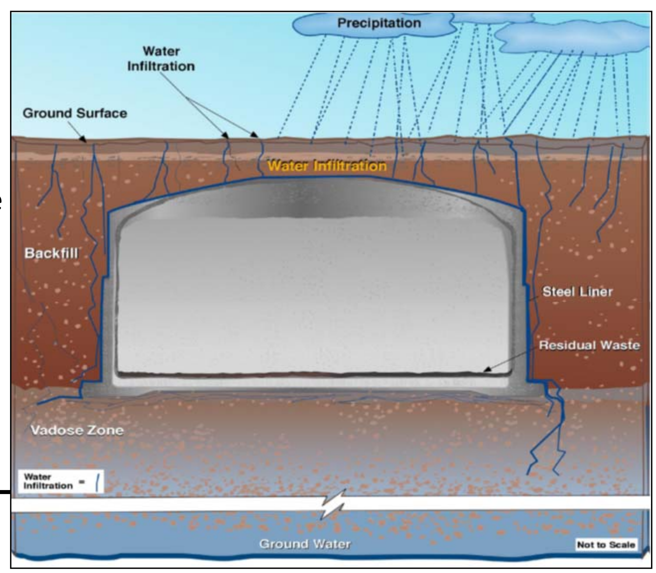
TECHNOLOGY NEED

This technology is needed to support future update of the Waste Management Area C (WMA C) Performance Assessment (PA) (RPP-ENV-58782), development of other WMA PAs, selection of closure technologies and future retrieval planning.

TECHNOLOGY SOLUTION

A review is planned to support future update of the WMA C PA, development of other WMA PAs, selection of closure technologies and future retrieval planning:

- Testing on residual waste samples from tanks to better define waste release characteristics (this task would not pay for sampling, just for the extra tests).
- Sampling and testing of concrete samples from tank walls of ancillary equipment, to learn more about tank concrete degradation.
- Evaluation of grout development and testing to better define waste release characteristics for final closed tanks.



Long-Term PA Maintenance Parameters

RISKS AND OPPORTUNITIES

RPP-009, Tank Farm System Landfill Closure is Legally Challenged
RPP-054, Facility Closure Costs are Not Fully Evaluated

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DEVELOPMENT TESTING OF HIGH-RADIATION HOSE MATERIALS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The technology for developing a material that will enhance the life expectancy of hose-in-hose transfer lines is in the planning stages. Completion of the scope would produce a viable material that would be field deployable and would extend the life of the waste transfer lines. This would satisfy project needs.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: RTW-10 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

All WRPS retrieval technologies use in-tank pumps to transfer radioactive tank waste. Waste slurry is pumped from the single-shell tanks through rubber hose-in-hose transfer lines (HIHTL), to valve boxes for re-routing the waste to the double-shell tanks. Several A Tank Farm tanks have highly radioactive waste (~43,000 R/hr total beta and ~365 R/hr gamma at the waste surface) that will compromise the hoses, considerably shortening their life expectancy.

Development and testing of high-radiation hose material will extend the life of the HIHTLs and improve tank retrieval operations performance.

TECHNOLOGY SOLUTION

The development approach includes preparation of specifications and a statement of work to award a contract with a commercial vendor(s) for the development and testing of materials for use in hoses for application in high-radiation areas. The research will include testing to meet the physical requirements (e.g., pressure, flexibility, temperature) of the hoses. Based on successful testing, a prototype hose material will be designed, fabricated, and delivered to the Hanford Site for final testing and deployment.

Rubber HIHTL

RISKS AND OPPORTUNITIES

Risk AAXPC-D16-R, Excessive Equipment Failures (Other Than Pumps)
Risk Waste-001-R, AW-02A Jumpers Fail (e.g., Buckling Relief Valve Failure) Causing Schedule Delays (Feed Tank)

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EVALUATE BACK-UP OPTIONS FOR HLW DELIVERY FROM TANK FARMS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The technology required to ensure particle size requirements for high-level waste feed are met is currently available, but may not be in a configuration required for deployment in Hanford Site tanks. Work to be performed here would take the technology to Technology Readiness Level 9.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: RTW-15 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

The waste acceptance criteria limit on maximum particle size in high-level waste feed to the Waste Treatment and Immobilization Plant Pretreatment Facility is 310 µm. If tank waste characterization and staging (TWCS) is unable to provide feed, a size segregation and/or size reduction technology could be deployed in the double-shell tanks and support feed delivery to the Pretreatment Facility. This could be accomplished by deploying the TWCS selected technology in the double-shell tanks or using the double-shell tank mixer pumps and an appropriately selected transfer pump elevation to perform the necessary particle size segregation.

TECHNOLOGY SOLUTION

The development approach is twofold: (1) through laboratory testing of a modified approach using concentrated supernatant and (2) through small-scale tank testing to confirm that the reaction dynamics are functional and understood for a full-scale tank. The process development would occur in a National Laboratory and may be followed up by a demonstration on actual waste in the 222-S Laboratory.

Small-Scale Testing Platform

RISKS AND OPPORTUNITIES

Risk RPP-013, Waste Feed Delivery is Not Available at the Demand Rate

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DEVELOP INTEGRATED HLW FEED QUALIFICATION PLAN

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

An integrated feed qualification program will allow for identification of gaps in capabilities and support an assessment of technology options that most appropriately fill the need.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: RTW-16 **Priority: Low** **Rank: N/A**

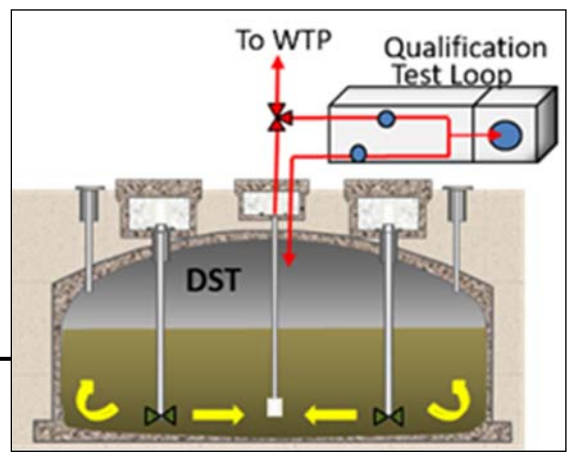
TECHNOLOGY NEED

The integrated high-level waste feed qualification program should be mature and completed long before the feed qualification samples are collected. To ensure the program is developed and operationally ready, tank farm characterization and/or simulant testing elements need to be performed well in advance of the operational need date.

TECHNOLOGY SOLUTION

The development approach is to jointly develop an integrated Waste Treatment and Immobilization Plant Tank Operations Contractor feed qualification program patterned after the operational program implemented at the Defense Waste Processing Facility. This program will identify technology gaps and needs that will then be evaluated for the preferred path forward.

Sampling Qualification Test Loop



RISKS AND OPPORTUNITIES

Risk RPP-013, Waste Feed Delivery is Not Available at the Demand Rate

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ACCESS DEEP SLUDGE PUMP RELIABILITY FOR DST MIXER &TRANSFER PUMPS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Determine the ability to stop and restart pumps in high-level waste feed delivery tanks.

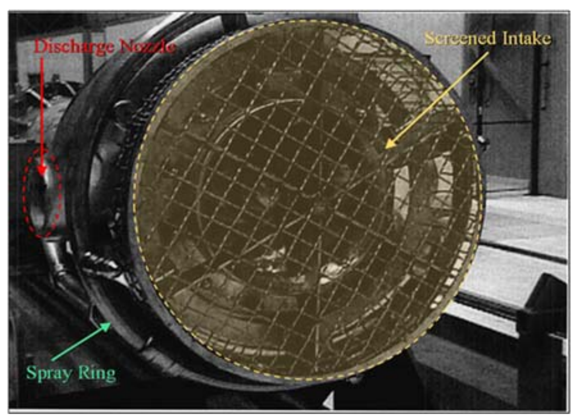
TEDS ID: RTW-17 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

The need is to test the limits of performance of full-scale mixer and transfer pumps to determine gaps and then develop technology-based solutions to ensure reliability when equipment is deployed in deep sludge conditions.

TECHNOLOGY SOLUTION

A program plan /engineering assessment will be developed that will consider the value and use of small-scale testing as a predecessor to full-scale testing. Work will include reviewing mixer pump test results performed for Savannah River Site and Hanford Site tanks. The next step would include obtaining scaled testing capability as recommend by the program plan . Note that the test facility may be available/capable of supporting other technology development needs.



Inlet of a deep sludge mixer pump

RISKS AND OPPORTUNITIES

Risk TFIRR-0029-T Pump Failure

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

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IMPROVED HEAT REMOVAL FOR AW & AN TANKS TSR HEAT LIMITS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Develop a twofold approach that uses models and engineering evaluations of ventilation system heat removal capacities, then evaluate alternate mixer pump configurations that use more but smaller pumps to mobilize waste, resulting in less heat input.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: RTW-18 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

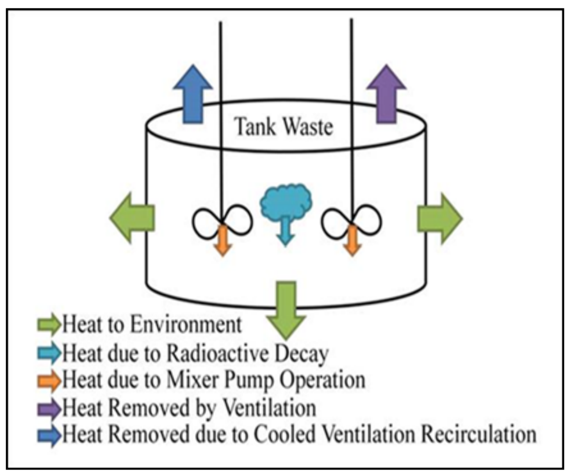
There is a risk that AW and AN Tank Farm tanks may exceed Technical Safety Requirement heat limits. Either improved heat removal or reduced heat input is needed. An evaluation of the trade-off to improve heat removal by new or modified systems or reduce heat input by changing the mixer pump configuration may identify new technologies to resolve the heat load risk.

TECHNOLOGY SOLUTION

The development approach is twofold:

1. Through modeling and engineering evaluations of ventilation system heat removal capacities.
2. Through evaluation of alternate mixer pump configurations that use more but smaller pumps to mobilize the waste.

This twofold approach should result in less heat input. The modeling will be similar to previous thermodynamic modeling of double-shell tank systems. The mixer pump configuration testing will utilize small-scale testing to demonstrate mixing effectiveness and will be combined with thermodynamic modeling to estimate the overall heat balance.



Model Energy Balance

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T DST Tank Failure in East Area

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TRU/SR-90 PRECIPITATION IN DOUBLE-SHELL TANKS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

In DSTs, Sr-90 and TRU precipitation can be performed in the tank farms rather than in the WTP Pretreatment Facility to increase mission efficiency.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: RTW-19 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

While a process has been developed for implementation in the Waste Treatment and Immobilization Plant (WTP), its implementation complicates and reduces the efficiency of the flow of material through the Pretreatment Facility. This process may be performed efficiently in double-shell tanks (DSTs), but the current process in the pretreatment requires dilution of DST waste to 5M sodium but the tank farm would prefer to do this strontium-90 (Sr-90) and transuranic (TRU) removal at a higher molarity to conserve space if the removal process were to be performed in the tank farm. The method of removing Sr-90 and TRU should be optimized for more concentrated solutions so that it can be implemented efficiently in the tank farm.

TECHNOLOGY SOLUTION

The potential development approach is threefold:

1. Laboratory testing of a modified approach using concentrated supernatant.
2. Small-scale tank testing to confirm that the reaction dynamics are functional and understood for a full-scale tank. The process development would occur in a National Laboratory and may be followed up by a demonstration with actual waste in the 222-S Laboratory. Development will include review and incorporation of lessons learned from monosodium titanite strikes at the Savannah River Site.
3. Consider use of the Radioactive Waste Test Platform for testing with real waste.

RISKS AND OPPORTUNITIES

Risk RPP-033, WTP PT Throughput LTA

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IMPROVE ESP – A THERMODYNAMIC MODELING PROGRAM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

WRPS already has ESP in use. However, the database of ESP could be continuously improved as need arises and more data is available.

TEDS ID: RTW-21 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

The ESP modeling results are routinely used to 'process decision making' such as how much water or caustic to add during waste retrieval, what solids form, etc. The current ESP program could use some improvements on areas such as aluminum solubility and metal/metal oxides/hydroxides dissolution in oxalic acid and in caustic. It has been found that ESP consistently under-predicts the solubility of aluminum or oxalate. Therefore, it is likely that we will require custom databases for these species. Also, systems of Na-NO_3-NO_2 and Na-F-PO_4 could benefit from improved prediction capability. That is possible only when more experimental data is collected and incorporated into the database.

TECHNOLOGY SOLUTION

The ESP developer, OLI, could be commissioned to investigate and develop needed customization of the ESP database. Data collection will be performed as necessary if literature research finds experimental data lacking.

OLI Flowsheet

RISKS AND OPPORTUNITIES

Risk RPP-013, Waste Feed Delivery is Not Available at the Demand Rate.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

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WASTE TRANSFER PIPE UNPLUGGING

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A method of unplugging transfer pipelines at the tank farms is needed. Methods of unplugging to include mechanical devices or pulsed fluidic systems could provide a functional solution to free obstructions.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

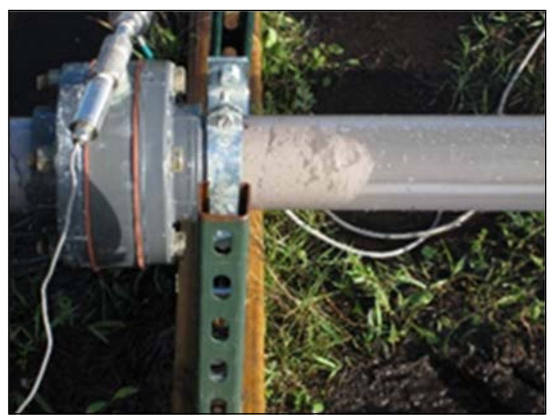
TEDS ID: RTW-23 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

The effect of a plugged transfer line can be devastating. It can impact all manner of waste transfers including tank retrieval efforts, feed to the 242-A Evaporator, cross-site transfers and feed of waste to the Waste Treatment and Immobilization Plant. While measures are taken to mitigate the potential for a plugging event, including maintaining critical velocities of flow and using heat trace to prevent cooling and precipitation, plugging events have historically occurred. The implications of a plug that cannot be removed are equivalent to a failed transfer line that must be removed from service. This puts a strain on the system's ability to support the mission efficiently and cost effectively.

TECHNOLOGY SOLUTION

Evaluation of market options and/or technology development of a unique solution for pipeline unplugging of the various primary pipe configurations throughout the tank farms waste transfer system would address the risk associated with the potential loss of a plugged transfer line.



Pipeline

RISKS AND OPPORTUNITIES

Risk TFIRR-0011-T Tank/Infrastructure Failures Prohibit Waste Transfers from DSTs in West area

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HIGHLY FLOWABLE GROUT

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

This technology is being implemented now to develop formulations for highly-flowable grout and C-200-series tanks closure grout.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 million
0-2 Years

TEDS ID: RTW-25 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

This technology is needed to support Waste Management Area (WMA) C closure required under Tri-Party Agreement Milestone M-045-83. The information to be gathered from these activities is needed to complete closure of the C-200-series tanks as one of the first steps in application of the Incremental Closure Approach for WMA C.

TECHNOLOGY SOLUTION

Highly-flowable grout and C-200-series tanks grout testing is meant to provide data needed to reach agreement among DOE, Ecology and WRPS for closure of the C-200-series tanks. The amount of testing required to achieve this purpose will be determined through meetings and discussions among WRPS, DOE and Ecology staff. That staff will be involved in the development of grout testing plans to ensure that their concerns are addressed to the extent practicable. All work would be performed at an offsite facility. The overall approach is as follows:

1. Conduct a review of grouting performed at other facilities and sites (e.g., 221-U Plant, Hanford 300 Area, other DOE sites) since development of RPP-RPT-41550, *Closure Demonstration Grout Test Report*.
2. Work with DOE, WRPS and Ecology staff to establish expectations and data needs.
3. Develop an initial set of grout formulations and sealing technologies to test.

RISKS AND OPPORTUNITIES

Risk RPP-013, Waste Feed Delivery is Not Available at the Demand Rate.

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IMPROVED SOLUBILITY MODELING OF ALUMINUM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Currently, improved solubility modeling is able to predict gibbsite precipitation with moderate accuracy in waste simulants containing only a select list of analytes. Proposed tests would provide the underlining solubility data needed to adjust the model parameters so that the model can predict gibbsite precipitation with acceptable accuracy.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: RTW-27 **Priority: Medium** **Rank: N/A**

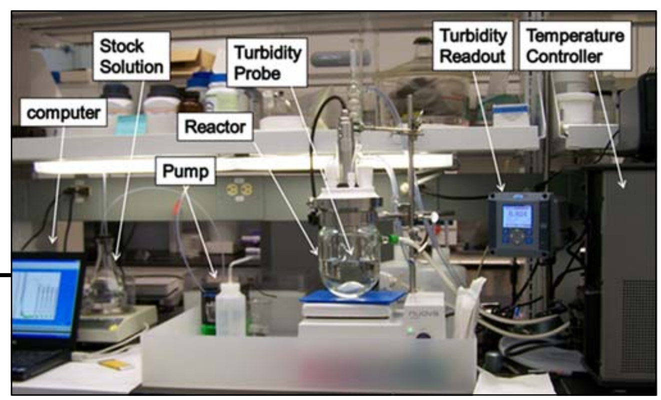
TECHNOLOGY NEED

Aluminate and gibbsite are key components in Hanford Site tank waste and aluminate solubility can be a driver in long-term mission planning. Many external groups have recommended improvements in the chemistry modeling used in long-term mission planning simulations. Having inadequate chemistry can lead to inadequate predictions of processing problems due to line or equipment plugging, movement of tank waste, mission end dates, and the quantities of immobilized low-activity waste and immobilized high-level waste.

TECHNOLOGY SOLUTION

Solubility experiments need to be conducted to understand the aluminate and gibbsite chemistry. Simulants could be used with the potential for real waste samples being used as well. Solubility experiments must be conducted to a high level of precision and accuracy so that the data can be used to develop thermodynamic models.

Laboratory Setup



RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate
DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

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SOLUBILITY MODELING OF OXALATE, FLUORIDE & OTHER SIMPLE MIXTURES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Currently, improved solubility modeling ability to predict oxalate and fluoride precipitation in waste simulants containing only a select list of analytes is poor.

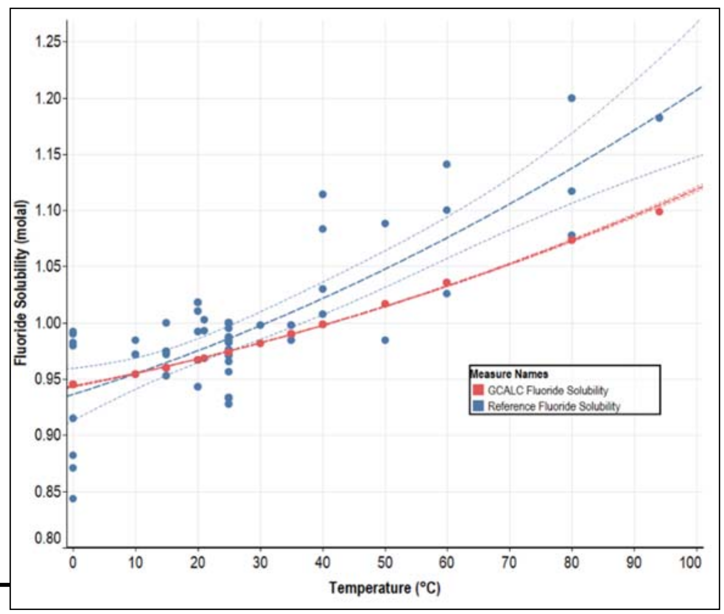
TEDS ID: RTW-28 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Oxalate and fluoride, and the precipitates formed from those ions, are key components in tank waste and their solubility can be a driver in long-term mission planning, such as the use of TOPSim. Many external groups have recommended improvements in the chemistry modeling used in long-term mission planning simulations. Having inadequate chemistry can lead to inadequate predictions of processing problems due to line or equipment plugging, movement of tank waste, mission end dates, and the quantities of immobilized low-activity waste and immobilized high-level waste.

TECHNOLOGY SOLUTION

Solubility experiments need to be conducted to understand the oxalate and fluoride solubility and the solubility containing mixtures of those and other components. Solubility experiments must be conducted to a high level of precision and accuracy so that the data can be used to develop thermodynamic models.



Fluoride Solubility Data

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate
DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

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IMPROVED SOLUBILITY MODELING OF PHOSPHATE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Currently, improved solubility modeling ability to predict phosphate precipitation in waste simulants containing only a select list of analytes is poor.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
3-4 Years

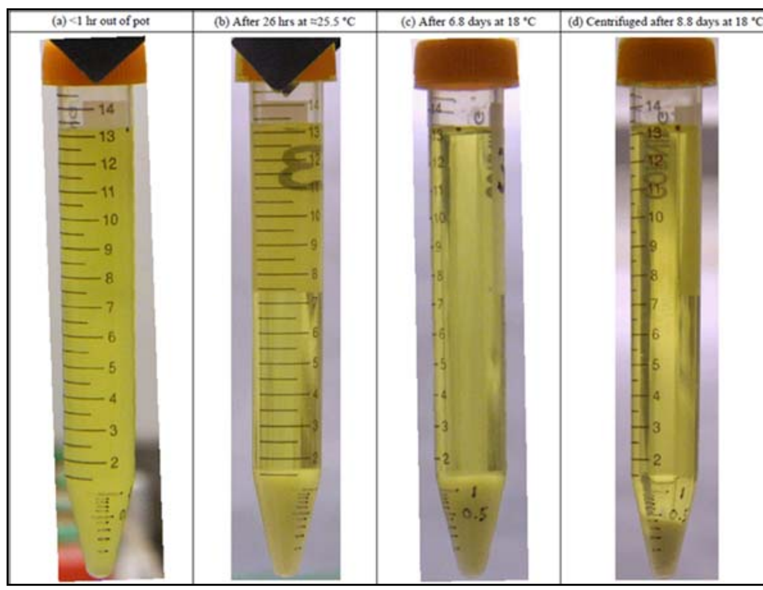
TEDS ID: RTW-29 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Phosphate is a key component in tank waste, and phosphate solubility can be a driver in long-term mission planning. Many external groups have recommended improvements in the chemistry modeling used in long-term mission planning simulations. Having inadequate chemistry can lead to inadequate predictions of processing problems due to line or equipment plugging, movement of tank waste, mission end dates, and the quantities of immobilized low-activity waste and immobilized high-level waste.

TECHNOLOGY SOLUTION

Solubility experiments need to be conducted to understand the phosphate solubility and its chemistry with various phosphate solids that can be precipitated in tank waste. Simulants could be used with the potential for real waste samples being used as well. Solubility experiments must be conducted to a high level of precision and accuracy so that the data can be used to develop thermodynamic models.



Phosphate Solubility Experiment

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate
DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

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IN-TANK SAMPLING TECHNOLOGIES FOR PLUTONIUM PARTICLES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A waste feed delivery strategy is needed that includes sampling and detection of plutonium particles that addresses potential criticality concerns.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
4+ Years

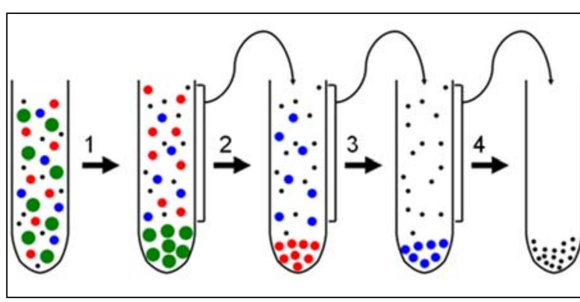
TEDS ID: RTW-31 **Priority: Low** **Rank: N/A**

TECHNOLOGY NEED

While numerous reports, such as RPP-RPT-50941 and RPP-RPT-54469, discuss the particulate plutonium inventories in the tank farms, uncertainties remain about the processing origins, conditions of formation, distributions and quantities of this plutonium (especially the plutonium-bismuth particles). Criticality safety requirements mandate providing capabilities to detect and characterize the particulate plutonium that will be retrieved, blended and transferred in the waste feed to the Waste Treatment and Immobilization Plant (WTP). The tank farms do not currently have the capability to sample for plutonium particulates with the representativeness and accuracy necessary for compliance with the criticality safety requirement.

TECHNOLOGY SOLUTION

Working with a National Laboratory, complete the problem definition (sampling locations and required accuracy). With a mature problem definition, identify potential technologies that could be applicable and down-select to the most promising candidate(s). Test these technologies, for example by work at small-scale to determine which technology should be tested at larger scale. Perform qualification testing at full-scale to validate that the technology meets the performance requirements.



Differential Centrifugation

RISKS AND OPPORTUNITIES

No technology risk per se, however there is a general project level risk that tank farms will be unable to qualify certain feed batches for delivery to WTP.

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NEUTRON POISONS FOR CRITICALITY SAFETY OF PARTICULATE PLUTONIUM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Develop the technology for delivering soluble neutron poisons into those tanks having high particulate plutonium inventories as a criticality safety control strategy. Demonstrate the chemical stability and effectiveness of the neutron poisons.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: RTW-32 **Priority: Medium** **Rank: N/A**

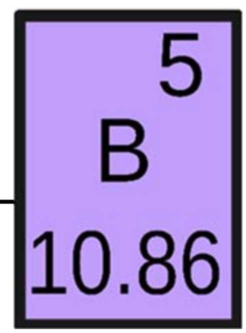
TECHNOLOGY NEED

Development of the technology to deliver neutron poisons will provide a criticality safety control strategy for retrievals of waste from tanks such as SY-102, TX-109, and TX-118. Development will address outstanding issues of chemical stability of the neutron poisons in the caustic waste environment. Design criteria for monitoring instrumentation that arise from the ANSI/ANS-8, *Fissionable Material Outside Reactors,* standard on soluble poison additions will also be addressed as required under DOE O 420.1C, *Facility Safety.*

TECHNOLOGY SOLUTION

Technology development will require a combination of waste experiments and computational fluid dynamics modeling as well as monitoring instrumentation design development.

Potential Neutron Poison



RISKS AND OPPORTUNITIES

Risk TFIRR-0046-T DST Tank Failure In West Area
Risk TFIRR-0048-T SST Failure in West Area

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INSTRUMENTATION FOR DETECTING PLUTONIUM ACCUMULATIONS IN TANKS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Instrumentation for the proposed plutonium monitoring is readily available, but the means of deployment need further development for tank farms conditions. Detector shielding and calibration may be technical issues.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

TEDS ID: RTW-33 **Priority: Low** **Rank: N/A**

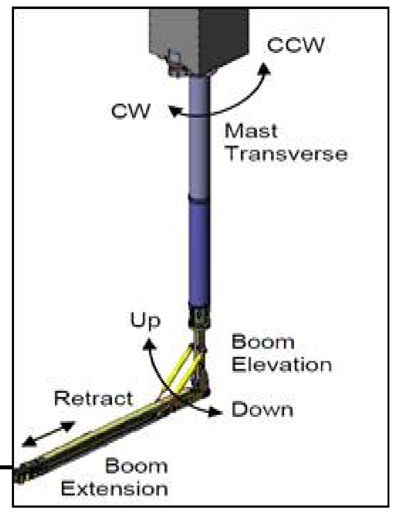
TECHNOLOGY NEED

A capability to detect the presence of plutonium accumulations on a tank bottom is needed as part of the required control strategy for addressing criticality safety issues. The technology would be deployed to ensure safety during retrieval of the SY-102 sludge and the TX-118 salt cake, as both tanks hold significant inventories of particulate plutonium. The capability to detect plutonium accumulations would address specific criticality requirements of DOE O 420.1C, *Facility Safety.*

TECHNOLOGY SOLUTION

Identify commercial instrumentation capable of detecting relatively small plutonium accumulations (e.g., ½-kg mound) within the high gamma radiation tank environment. Given instrument capabilities, identify equipment needed for deployment to scan tanks for plutonium. Equipment might be, for example, riser arms, detector arrays or tank bottom robotics.

Robotic Arm Deployment Option



RISKS AND OPPORTUNITIES

There are company-level risks associated with not yet having a criticality control strategy that allows retrieval and transfer of the tank wastes that hold particulate plutonium. While the particulate plutonium is only in a few tanks and WTP feed delivery schedules may be delayed, there are risks with unplanned needs to retrieve and transfer waste to other tanks. There are also risks associated with proposals that the WTP Pretreatment facility can operate based on particulate plutonium mass controls implemented by measurements of plutonium mass at the tank farms.

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EXTENDED REACH SLUICING SYSTEM MODIFICATIONS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The extended reach sluicers currently cannot travel vertically along the mast. In some instances the mast length requires replacement of sluicers prior to completion on retrieval due to lack of reach.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

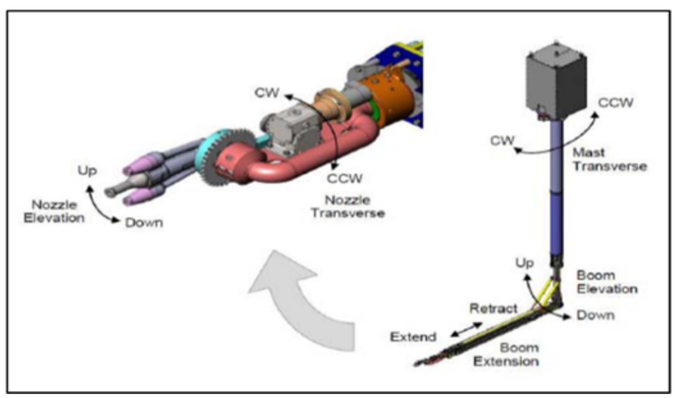
TEDS ID: RTW-34 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

To date, the Tank Operations Contractor (TOC) has successfully utilized the extended reach sluicing system (ERSS) for single-shell tank waste retrieval. The ERSS functions much like a human arm. The first subassembly, the mast, is similar to the upper portion of the human arm – from the shoulder to elbow – and extends into the tank and has a fixed length. The second subassembly is similar to the lower portion of the human arm – from the elbow to the wrist – and is extendable downward and outward from the mast. The third section is similar to the wrist and hand, the end effector – and contains both the high- and low-pressure spray nozzles – is used to mix tank sludge into solution. The radioactive tank waste is then transferred from the single-shell tank to double-shell tanks. The ERSS is beneficial for tanks with significant sludge volume (>2 ft) and/or in-tank obstructions; however, the ERSS equipment is expensive and requires long lead times to procure.

TECHNOLOGY SOLUTION

The development approach for a viable simplified sluicer includes: preparation of a specification, completion of an Expression of Interest and down selection, awarding a contract, and fabrication and testing. Development is funded by Closure & Interim Measures.



Extended Reach Sluicing System

RISKS AND OPPORTUNITIES

Risk AAXRC-0016-T Excessive Equipment Failures (other than pumps)

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RISK-INFORMED TANK RETRIEVAL MODELING OPTIMIZATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

This optimized risk model enhances the risk outcomes from the system model by including other relevant factors (i.e., waste volume, leak status, waste type, worker impacts from retrieval, and cost of retrieval) which will reduce the overall costs of tank retrieval and the management of space in the double-shell tank system easier.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: RTW-39 **Priority: High** **Rank: N/A**

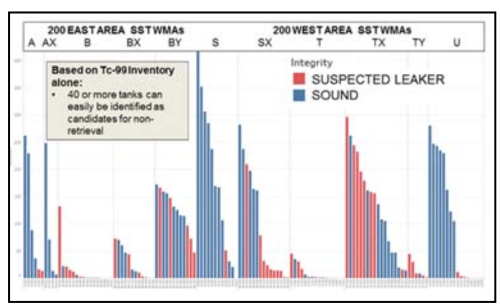
TECHNOLOGY NEED

A volume-based retrieval standard has been used as defined in the Tri-Party Agreement and Consent Decree. Single-shell tanks (SSTs) vary significantly in their risk characteristics. Retrieving tanks that do not pose a significant risk increases mission cost and increases worker exposure. The objective of the work is to develop an analysis capability that would provide the technical basis for DOE to apply a risk-informed strategy for future tank retrievals and closures.

TECHNOLOGY SOLUTION

This proposed technology development will provide the technical basis and regulatory approach for developing a risk-informed set of retrieval requirements to replace the current volume-based retrieval requirement. This will ensure that mission resources are applied to achieve real risk reduction and avoid retrieval actions that do not have a risk reduction benefit. Specific research objectives include:

- Adapt existing performance assessment models for Waste Management Area (WMA) C and WMA A-AX.
- Evaluate other factors that could be important in determining the risk impacts and benefits of retrieval.
- Develop the regulatory approach and basis for modifying the Tri-Party Agreement's existing volume-based retrieval approach.
- Identify incremental sampling analysis for WMA A-AX tanks that could better inform this retrieval strategy.



Tc-99 (Ci) in SSTs

RISKS AND OPPORTUNITIES

Risk DFLAW-008-R, Inadequate DST Space

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COMPUTER SIMULATOR TO MEASURE RETRIEVAL OPERATOR SKILLS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

An ergonomic cockpit environment to control robots in waste tanks is needed. Develop similar forms of task analysis, metrics, and a computer simulator for the training and operational benefit of tank farm retrieval operators as those used for measuring and modelling robotic surgical skills.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: RTW-43 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Improvement in the efficiency of tank retrieval operations based upon improvements to the human-machine interface are needed. A system is needed that records operator action; this will lay the groundwork for a future low cost integration effort to add operation control action logging to the existing operational waste retrieval system.

TECHNOLOGY SOLUTION

This project will consist of four subtasks:

Simulator

1. Task analysis and post-action analytics. The team will review copies of logs and videos of completed waste tank retrieval operations to form the raw data for task analysis.
2. Simulator development. The team will select an appropriate operating system platform for the simulator.
3. User interface hardware development. During actual tank retrieval, the mobile-arm retrieval system and similar arms are controlled using an industrial control panel consisting of a National Electrical Manufacturers Association-rated enclosure and several joysticks and button controls. The controls will mimic the actual layout, feel, and control actions of the existing retrieval arm console and have identical labels.
4. Operator training study. Four users with no experience will be selected from the University of Washington student body. They will view a set of training slides and then perform a set of exercises in on the simulator. Procedures for the learning curve study will be submitted for prior approval to the University's Human Subjects Institutional Review Board.

RISKS AND OPPORTUNITIES

Risk AAXRC-0044-T Inability to Adequately Staff the Project

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USE OF SONAR & ULTRASOUND TO QUANTIFY SOLIDS IN DSTS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A combination of sonar and ultrasonic sensors enables 3D profiles of settled solids and in situ measurements of the concentration of suspended solids to determine total volume of undissolved solids. Time-of-flight sonar will provide topography of the settled solids (i.e., bottom profile) based on integrating scans of 2D profiles.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
0-2 Years

TEDS ID: RTW-44 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

This technology could reduce the uncertainties and therefore conservatism used by current methods that rely on localized (i.e., point) contract measurements of settled solids levels and sampling to measure suspended solids concentrations.

TECHNOLOGY SOLUTION

The suspended solids concentration changes waste characteristics (e.g., rheology, settling rate) and system performance (e.g., mixing, pipeline transfer). Solids concentration is an important parameter for estimating slurry rheology and pipeline critical velocity, performing hindered settling calculations, and developing waste acceptance criteria for direct-feed low-activity waste. Furthermore, more accurate undissolved solids accounting enables the tank farm contractor to reliably rebalance tank contents, maximizing the double-shell tank solids inventory and freeing up space. Knowing where the solids are predominantly located is also very important. This information will be critical for modeling chemical addition methods for out-of-specification wastes, and where chemicals should be added so they will not migrate to one side of the tank or the other.

The instrumentation allows tracking of interface and suspended solids concentration concurrently as a function of time. Knowledge of time to settle to a desired level and concurrent supernatant concentration provides the ability to initiate transfers when target decant conditions are attained, expediting waste processing.

3D Profiling Sonar & Controller

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T DST Tank Failure in East Area
Risk TFIRR-0046-T DST Tank Failure in West Area

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BARRIER TECHNOLOGY RESEARCH

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Barrier technology is in the planning stage, requiring development from the ground up. Completion of the research would produce a report that presents deployable barrier options to allow existing retrieval techniques for leaking tanks.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: RTW-52 **Priority: Medium** **Rank: N/A**

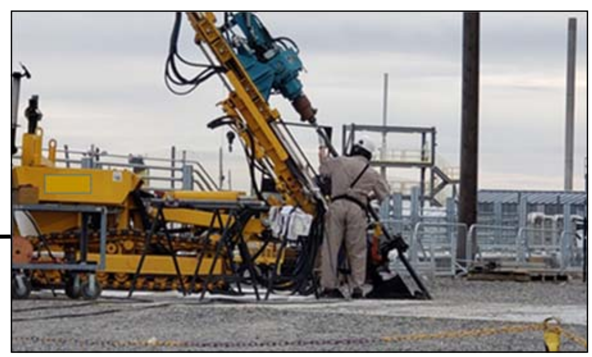
TECHNOLOGY NEED

Hazardous and radioactive tank waste has migrated to the groundwater from surface spills and tank leaks, due to years of waste: storage, transfer and retrieval. There is a potential for future spills, tank leaks and active migration of past and future leaks. Barrier technology would provide a boundary between the waste source and ground water. The barrier would immobilize contamination at the surface, in the tanks or beneath the tanks, preventing waste from reaching the ground water. Additionally, for leaker-tanks, this technology would allow the use of conventional and new retrieval methods.

TECHNOLOGY SOLUTION

The development approach for barrier research includes performing market research and preparing a report on the potential barrier technologies in support of single-shell tank retrieval. One Technology identified is to use Direct push technology to inject material to act as a barrier during tank waste retrieval.

Direct-Push Rig Angle Drilling



RISKS AND OPPORTUNITIES

Risk TFIRR-0047-T SST Failure in East Area and TFIRR-0048-T SST Failure in West Area

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THREE-DIMENSIONAL FLASH LIDAR

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Three-dimensional flash LIDAR will improve tracking capabilities. The system will map important mission features (e.g., waste, equipment, waste containers).

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: RTW-53 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

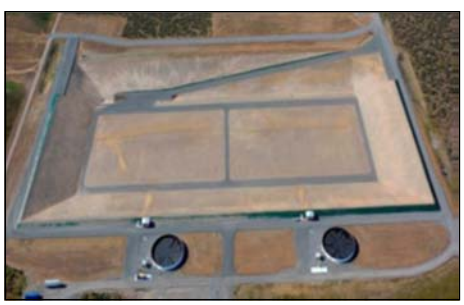
There are many applications with which improved configuration and documentation are required. Three-dimensional flash light detection and ranging (LIDAR) will improve tracking capabilities. The system will map important mission features (e.g., waste, equipment, waste container disposal). Currently, extensive expenditure of time and material are required to provide this information.

TECHNOLOGY SOLUTION

Retrieval Application – This development process will use various simulated wastes to determine if it can map contours under water and any other limitations would then need to occur.

IDF Application – This development process will need to demonstrate standoff capability to map waste disposal of containers of glass, low-activity waste melters, secondary waste disposal packages, and other items disposed of at the Integrated Disposal Facility (IDF). The data collected will be required to interface with the Waste Management Information System.

Equipment Application – This demonstration process will need to show accurate configuration of equipment and pit liners to allow remote in-service inspections to satisfy regulatory and code requirements.



Integrated Disposal Facility

Typical Central Pump Pit

RISKS AND OPPORTUNITIES

Risk: WRPSC-0011-T Unexpected Field Conditions Encountered

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TANK WASTE MODULAR TREATMENT STUDY

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Modular treatment has been shown to have the capability to increase low-activity waste loading by nearly 30%.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: RTW-54 **Priority: High** **Rank: N/A**

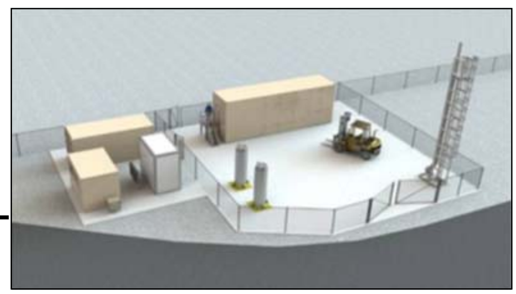
TECHNOLOGY NEED

Modular treatment has been shown in the subject proposals to have the capability to increase low-activity waste loading by nearly 30%, to treat waste in west area concurrently, which contains more technetium-99 and pumpable liquids and is therefore a higher groundwater risk, and ultimately to provide a back-up plan to current mission strategy and a significant potential to shorten the duration of the current mission.

TECHNOLOGY SOLUTION

Paper study using an engineering cost-benefit analysis approach, possibly integrated with system planning efforts.

Modular Treatment Facility Sketch



RISKS AND OPPORTUNITIES

Risk: TFIRR-0011-T Tank/Infrastructure Failures Prohibit Waste Transfers from DSTs in West area
Opportunity OPP-004, Alternate Supplemental Treatment Technology Development Results in an Acceptable Process That Improves Cost and/or Schedule Performance Against the Assumed Baseline

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HANFORD WASTE END EFFECTOR (DEPLOYMENT OPTIONS)

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A modified version of previous retrieval technology being developed for unique Hanford Site retrieval scenarios. The phases of development are geared toward full deployment for an SST retrieval. Full implementation of this would result in a deployed HWEE retrieval system.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1-$5 million
0-2 Years

TEDS ID: RTW-55 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Existing sluicer technology requires excessive water consumption leading to increased waste volumes. The Hanford Waste End Effector (HWEE) was proven to be more efficient (i.e., less water consumption) than the extended reach sluicing system (ERSS) in simulated waste testing.

TECHNOLOGY SOLUTION

The HWEE is being developed in a phased approach with the known challenges in mind:

- **Phase I:** End effector down select, identifying a confined sluicer to optimize water usage during retrieval. This was completed in FY 2017.
- **Phase II:** End effector positioning, and effectiveness demonstration. Includes conveyance testing, development of end effector positioning, including the ability to avoid expected obstructions in a single-shell tank (SST) and demonstrate the effectiveness of the integrated HWEE system. This was completed in FY 2018.
- **Phase III:** HWEE adaptation to an ERSS articulated mast with functional test by vendor FY 2019.
- **Phase IV:** Functional cold test HWEE at CTF with articulated mast using simulant with emphasis on conveyance capability. To be completed in FY 2020.

FY 2019 Functional Test

HWEE Attached to ERSS Arm

RISKS AND OPPORTUNITIES

Risk AAXRC-0011-T Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved
AAXRC-0020-T Retrieval System Tank Leak

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TECHNOLOGY TO SUPPORT RISK-BASED RETRIEVAL & CLOSURE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The proposed technology has the potential to greatly reduce the amount of liquids introduced to double-shell tanks during retrieval by optimizing retrieval endpoints and reducing the number of retrieval operations conducted.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

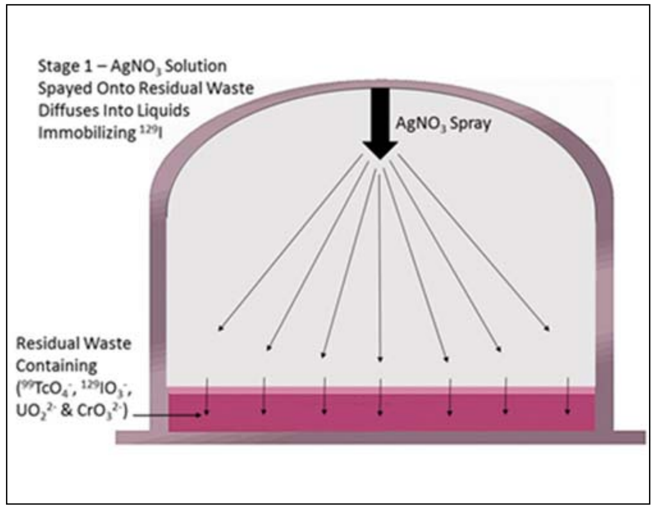
Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: RTW-56 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

An alternative Hanford tank closure option would be to use effective in-tank chemical stabilization of risk-driving contaminants that supports the use of technically defensible tank retrieval endpoints and demonstrates significant reduction of risk to human health and the environment.



Application of Getters

TECHNOLOGY SOLUTION

The proposed technology uses silver nitrate and zero-valent iron to transform technetium, iodine-129, chromium and uranium to insoluble forms that can substantially reduce their leachability from residual waste left in tanks after retrieval. The technology is planned to be implemented by first spraying silver iodide onto the top of the tank waste so it will diffuse into the waste and cause precipitation of any soluble iodine-129 as silver iodide in the entrained liquids of the waste. Next, the waste is planned to be covered with a grout formulation that contains zero-valent iron. This is expected to release +2 valent iron into solution which will diffuse into the entrained liquids in the residual waste. This will cause any dissolved technetium, chromium, and uranium, as well as silver to precipitate. This grout layer can also prevent the system from re-oxidizing by scavenging oxygen from any water that infiltrates into the system. Permitting implications for this approach will be reviewed.

RISKS AND OPPORTUNITIES

Risk AAXRC-0004-T Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved

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PLUTONIUM/ABSORBER MASS RATIOS MEASUREMENT

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Technology capable of sampling and/or directly measuring plutonium-to-neutron absorber mass ratios in retrieval waste streams to support criticality safety control strategies for retrieval operations.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

TEDS ID: RTW-57 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Technology for measuring plutonium-to-neutron absorber mass ratios is needed to support the criticality safety evaluation of operations to dissolve AX-104 sludge with oxalic acid. Another application would be with retrievals from the SY-102, TX-118 and TX-109 tanks that have high inventories of particulate plutonium. The neutron absorbing materials of primary concern are iron, manganese and boron-10, while additional absorbers, such as nickel, silicon, aluminum and sodium are secondary concerns. Ideally, the measurement technology would be able to quantify the plutonium in either the large particle or co-precipitated forms.

TECHNOLOGY SOLUTION

Capability to measure plutonium/absorber mass ratios would establish compliance with evolving interpretations of requirements under the ANSI/ANS 8.14, *Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors,* criticality safety standard. The standard is being extended, under limited conditions, to be applicable for insoluble neutron absorber materials, such as the iron and manganese credited for ensuring safety of the plutonium in the tank waste. The standard requires verifications of fissile plutonium and absorber inventories during processing.

Current tank waste sampling techniques provide plutonium/absorber inventories under only static tank conditions. As waste is retrieved, some separation of plutonium/absorbers occurs, for example, due to different dissolutions rates under caustic or acidic conditions. Monitoring of dynamic conditions as waste is retrieved can assess effects of plutonium/absorber separation as waste solids dissolve or assess effects of particulate plutonium segregation of lighter absorber materials due to fluid dynamic conditions.

RISKS AND OPPORTUNITIES

Risk AAXRC-0070-T Oxalic Acid Cannot be Added to Tanks
Risk TFIRR-0045/46-T DST Tank Failure In East/West Area

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5.3 Process Tank Waste

The PTW functional area focuses on methods through which Hanford Site tank wastes must be retrieved from the tank farms and safely immobilized into stable waste forms for disposal. The baseline method for Hanford Site waste immobilization is vitrification. As part of the WTP design basis, the retrieved waste will be separated into LAW and high-level waste (HLW) fractions at the WTP Pretreatment Facility. Some of the LAW will be vitrified into borosilicate glass at the WTP LAW Vitrification Facility. The HLW fraction of the waste will be vitrified into borosilicate glass at the WTP HLW Vitrification Facility. The LAW Vitrification Facility alone was never intended to treat the entire inventory of Hanford Site LAW in the same period as the HLW can be treated. Supplemental immobilization was proposed to treat part of the LAW (ORP-11242). The proposal was based upon use of the minimum requirements in the WTP Contract assumed to be the basis of the full capability of the plant. Technologies that have been considered for immobilization include joule-heated melter vitrification (similar to WTP), grout (cast stone), fluidized bed steam reforming, and bulk vitrification. However, the scope of the supplemental immobilization and treatment projects have been deferred until a date yet to be determined and the final decision will require both programmatic and regulatory review. The scope of these projects will be made after the startup of DFLAW operations. The need for supplemental LAW capacity and its nature are indeterminate. Therefore, additional supplemental treatment technology elements will be added after that decision is made.

The TOC is committed to providing support for startup of the LAW Vitrification Facility by designing and deploying the DFLAW pretreatment facilities that will enable early facility startup.

As the RPP mission transitions from managing and retrieving tank farms to waste treatment operations, the need exists to understand the flowsheet interactions that may occur and to anticipate the implications this interconnectedness may cause with respect to chemical interactions, process flows, unit operations, and effluent management. The RPP mission is examined holistically to develop integrated process flowsheets from the individual process flowsheets that comprise each aspect of the RPP mission. The portions of RPP-RPT-57991, *One System River Protection Project Integrated Flowsheet*, that are of greatest importance for the scope of the Roadmap are those that directly impact the tank farms and future waste treatment support of DFLAW.

The PTW function includes the following focus areas:

1. DFLAW Pretreatment Operations – Uses filtration to remove suspended solids containing alpha-emitting TRU nuclides and highly radioactive strontium-90, and ion exchange (IX) using crystalline silicotitanate (CST) resin to remove cesium-137 from supernatant tank waste.
2. Effluent Management Facility (EMF) – During DFLAW operations, evaporation will be performed in the planned EMF. The volatile and corrosive halide and sulfate components are highly concentrated in this stream because they are volatile at melter operating temperatures.
3. WTP LAW – The LAW Vitrification Facility has been designed to vitrify LAW into borosilicate waste glass using a joule-heated, ceramic-lined melter system. That facility will generate a substantial volume (i.e., millions of gallons per year) of liquid secondary waste (LSW) from the off-gas treatment system.
4. WTP HLW – The HLW Vitrification Facility has been designed to vitrify HLW into borosilicate waste glass using a joule-heated, ceramic melter system.

5. WTP Pretreatment – Receive waste from the tank farms (supernate) and Tank Waste Interim Characterization and Storage Facility (HLW slurry). It is designed to separate tank waste into HLW and LAW fractions via filtration and IX and provides evaporative capabilities.
6. Tank Waste Characterization and Staging – Provide a compatibility bridge between sludge wastes stored in the tank farms and the WTP receipt systems to ensure delivered waste is within the WTP waste acceptance criteria.
7. CH-TRU Tank Waste – Current assumptions are that 11 SSTs containing CH-TRU tank waste will be treated at a supplemental TRU treatment facility and then stored onsite at the Central Waste Complex until final disposition is determined.

Sections 5.3.1 and 5.3.2 include the catalog sheets for the funded and unfunded technologies, respectively, that fall under the PTW function.

5.3.1 PTW Catalog Sheets – Funded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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METHODS FOR MITIGATING DFLAW FLOWSHEET GAPS

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Laboratory and engineering-scale testing will be conducted to assess alternative processing technologies for various EMF feed and effluent streams. This work will address gaps in the baseline DFLAW flowsheet on partitioning and treatment of key COCs, determine if the WTP liquid effluent sent to the LERF/ETF will meet ETF WAC for delisting organics, evaluate the opportunity to purge the EMF bottoms and redirect to an alternate disposal path, and address recycle risks.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: PTW-23 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Technology development and maturation activities are needed to address limitations in Waste Treatment and Immobilization Plant (WTP) operations caused by the Effluent Management Facility (EMF). This includes laboratory and pilot scale tests to:

1. Address gaps in direct-feed low-activity waste (DFLAW) flowsheet on partitioning of key chemicals of concern (COCs) Tc-99, I-129, Hg, and organics within the melter and off-gas treatment system.
2. Determine if the liquid effluent from the WTP sent to the Liquid Effluent Treatment Facility (LERF)/ Effluent Treatment Facility (ETF) will meet ETF waste acceptance criteria (WAC).
3. Identify and develop solutions for COCs that exceed the LERF/ETF WAC or other regulatory requirements.
4. Demonstrate the efficacy of purging EMF bottoms to alternate disposal path to increase DFLAW throughput, reduce immobilized low-activity waste (ILAW) container count, and free space in double-shell tanks.
5. Address risk associated with high sulfate and high halide concentration in EMF bottoms recycle, fluctuations in the waste feed composition, reduction in waste loading/increased ILAW glass container count.

TECHNOLOGY SOLUTION

Laboratory and engineering-scale testing will be completed to address project uncertainties to identify possible risks to meeting regulatory requirements. Mitigation strategies will subsequently be developed and tested. Key FY 2020 activities to support this include:

- Develop and test iodine removal media and reactor technologies capable of targeting the species of iodine observed in FY 2019 tests in the caustic scrubber liquids and EMF evaporator overheads.
- Evaluate extent of the natural potential for biological activity in the LERF basin to reduce the concentration of organics in WTP liquid effluent.
- Assess organic destruction technologies that can augment ETF operations and aid in meeting waste disposal requirements.
- Consolidate and analyze FY 2019 Hg speciation test results to determine if they indicate a deleterious impact on the ability of the LERF/ETF to accept WTP liquid effluent.
- Demonstrate at 1/10 scale the physical and 99-Tc release properties of optimized cementitious waste forms for simulated EMF bottoms and develop an IDF PA data package for evaluation of onsite disposal.

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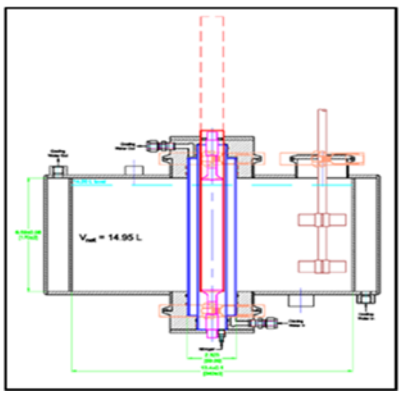
METHODS FOR MITIGATING DFLAW FLOWSHEET GAPS

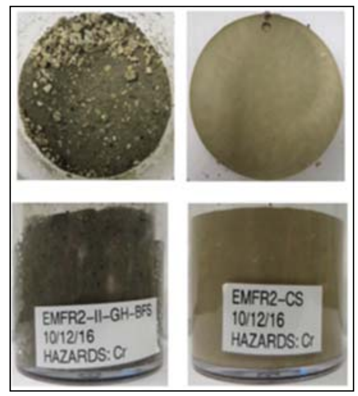
ADDITIONAL TECHNICAL INFORMATION

TEDS ID: PTW-23 Continued

Key remaining activities beyond FY 2020 associated with end-state completion of this project include:

- **Organics** – Down select treatment method and complete engineering-scale demonstration using ETF simulant and laboratory-scale tests with real waste.
- **Iodine** – Complete media testing to determine process scale-up properties, down-select reactor and process design and conduct engineering-scale testing.
- **EMF Purging** - Select a vendor for offsite treatment of EMF bottoms waste stream; determine if solidified EMF bottoms can be disposed of at an offsite location or if it must be disposed in the IDF; and complete a large-scale demonstration for immobilization of the EMF bottoms waste stream.





Example of work in progress: Laboratory-scale UV light reactor to test organic destruction (Right), Packed columns to test removal of COCs from aqueous media (Center), Solidified EMF-type waste (Left).

COST AND SCHEDULE SUMMARY

WBS number: 5.03.12.02.03

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Investigating chemical composition of WTP off-gas waste stream, COC retention in glass and CO partitioning in melter system	■	■	■	■	■	■	■	■	$2,600
Removal of Tc from EMF bottoms waste stream	□	□	□	□	□	□	□	□	$0
Funding In Thousands (000s) Per Year	$1,300				$1,300				$2,600

RISKS AND OPPORTUNITIES

Risk ETFOP-0059-T, Secondary Waste Form Uncertainty

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OPERATIONS PRODUCTIVITY & ANALYSIS TOOLS

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Develop a common set of productivity and analysis tools that gather together data from a variety of sources and transforms it into real time, reliable information for tank farm decision makers.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: PTW-28 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

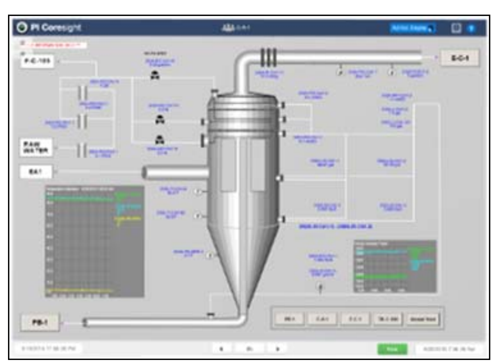
The strategy is to provide Tank Operations Contractor (TOC) operations with tools to improve facility status control, the quality of their communications quality and reduce the time required to determine the status of the facility. Examples of the tools being employed are:

1. **Operations Tracking Tools (OPS Tracker)** – Gather the status of completed and non-completed.
2. **Maintenance Work Tools** – Work package and Round Sheets and allows filtering by Operations team.
3. **Electronic Turnover** – Provides shift personnel a web platform to document the plant status at shift turnover.
4. **Limiting Condition of Operation (LCO) Tracking Program** – Shows when the LCO was entered and lists the Required Actions and time needed to exit the LCO.
5. **Electronic Rounds** – Provides Operators hand-held data collection devices, which eliminates data transcription errors and provides instant feedback for out of specification readings.
6. **System Deviation** – Shows all active temporary modifications, bypasses and logbook instructions.
7. **Survey Maps** – Provides the ability to display and update electronic radiological maps for each tank farm.

TECHNOLOGY SOLUTION

The strategy is to provide TOC operations with tools to improve the status control and quality of their communications and reduce the time required to determine the status of the facility.

Examples of new HPI improvement Tool for Operations to be developed are Electronic Material Balance, Electronic Logs, Waste Transfer Route Map, Electronic Routing Board, Industrial Hygiene Communication Boards, Best Basis Inventory Management, Waste Characterization, Operator Turnover and Work Week Planning.



PI Core Sight Display

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OPERATIONS PRODUCTIVITY & ANALYSIS TOOLS

ADDITIONAL TECHNICAL INFORMATION

TEDS ID: PTW-28 Continued

Alarm & Analysis Tracking Tool

Industrial Hygiene Communications Board Kiosk

Laboratory Information Status Board

COST AND SCHEDULE SUMMARY

WBS numbers: 5.1.1.13.25, 5.1.1.13.27, and 5.1.1.13.28

Project or Activity	FY20 Q1	FY20 Q2	FY20 Q3	FY20 Q4	FY21 Q1	FY21 Q2	FY21 Q3	FY21 Q4	Totals
Group #3 RadCon, IH and Operations Products	■	■	■	■	□	□	□	□	$1,500
Group #4 Eng., RadCon, IH and Operations Products	□	□	□	□	■	■	■	■	$1,500
Funding in thousands (000s)	$1,500				$1,500				$3,000

RISKS AND OPPORTUNITIES

Risk WRPSC-0010-T Complex Integration of Field Work
Risk WRPSC-0011-T Unexpected Field Conditions Encountered

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RADIOACTIVE WASTE TEST PLATFORM

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Develop test platform that will provide bench scale unit operations for DFLAW. Capability for troubleshooting, waste feed qualification data, check new unit operations, and close flowsheet gaps such as Effluent Management Facility bottoms being immobilized and sent offsite. Future capability can help with high-level waste flowsheet as well.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: PTW-38 **Priority: High** **Rank: N/A**

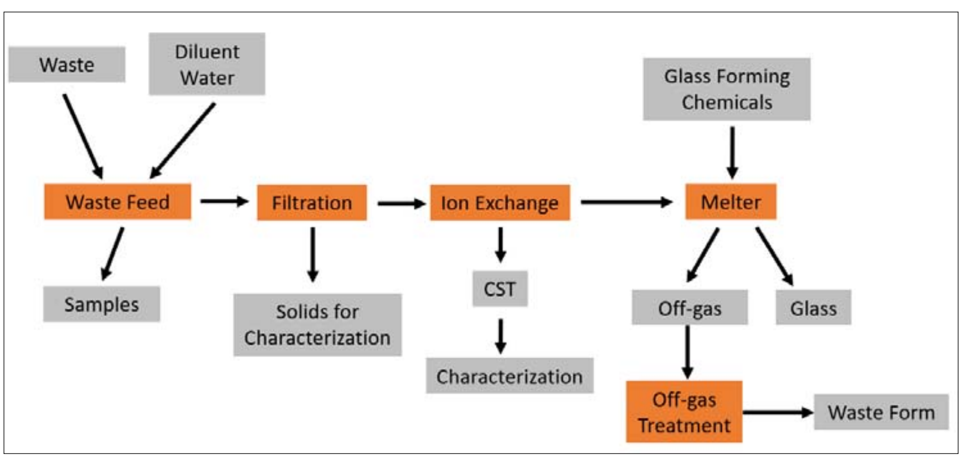
TECHNOLOGY NEED

Provide a test platform that supports unit operations troubleshooting, waste feed qualifications, flowsheet validation and tank-side cesium removal (TSCR) design input. The technology tool (platform) is needed, otherwise there would be no way to predict how each tank waste will react within the full-scale plant. Having the platform provides a means to troubleshoot operational issues, understand efficiencies of the filtration and ion exchange column and reduce the risk to the full-scale plant.

TECHNOLOGY SOLUTION

A test platform is needed to address flowsheet gaps and inform future direct-feed LAW (DFLAW) operations. A scaled test platform will enable completion of the following tasks: waste feed preparation, filtration, ion exchange, solid waste form production and melter condensate recycle. The platform is intended to contribute to both LAW and HLW treatment. Future applications include:

- Understand specific tank chemistry with individual unit operations
- Inform production operations
- Process troubleshooting and evaluation
- High-level waste sludge and crystalline silicotitanate (CST) melts
- Tank batch qualifications for CST usage
- Increase waste loadings for glass
- Opportunistic samples (after decontamination)
- Any new operation validation and design input.



Process Flow Diagram for the Radioactive Waste Test Platform

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RADIOACTIVE WASTE TEST PLATFORM

TEDS ID: PTW-38 Continued

ADDITIONAL TECHNICAL INFORMATION

Hot Cell

Melter

Cells Unit Filter

COST AND SCHEDULE SUMMARY

WBS numbers: 5.03.01.07.05.12 and 5.03.12.02.06.03
Note: Includes project support, sampling and waste disposal.

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Project Support	■	■	■	■	■	■	■	■	$600
Tank Sampling	■	□	□	□	■	□	□	□	$540
Test Platform	■	■	■	■	■	■	■	■	$6,231
Funding In Thousands (000s) Per Year	$3,910				$3,761				$7,371

RISKS AND OPPORTUNITIES

Risk TSCRP-0939-T: TSCR design/build subcontractor performance is LTA

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REAL-TIME PROCESS CONTROL FOR DFLAW

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Establish real-time monitoring process control for DFLAW, including demonstrated plant instrumentation to reduce the need for extensive process control samples. Sampling and analysis will be limited to periodic verification and confirmation.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

TEDS ID: PTW-54 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Process control for direct-feed low-activity waste (DFLAW) operation relies on process sample collection and analysis for composition information. The process cycle times for many vessels in the Low-Activity Waste Vitrification Facility and Effluent Management Facility is very short, requiring an increased number of samples to support operations. Additionally, the sampling and analysis duration coupled with the increased number of samples will challenge operations. This burden on the laboratories and impact on the process cycle time has the potential to impact operational throughput.

TECHNOLOGY SOLUTION

Applying a combination of automated material balances with selected real-time in-line monitoring with laser-induced breakdown spectroscopy (LIBS) or Raman probes will reduce the number of samples required and avoid process delays due to time-consuming sample analysis. Proven analytical modeling techniques can be adopted for use with the unique Hanford Site tank treatment matrices and analytes and for application to radioactive operations. The goal of the technology development is to limit sampling and analysis to periodic verification and confirmatory needs with the as low as reasonably achievable exposure goal of significantly reducing sample collection and time-consuming conventional analysis while maintaining compositional uncertainties within acceptable levels. Any implementation of real-time process control instrumentation requires an understanding of uncertainties and their impact on modeling (e.g., glass models).

LIBS Probe

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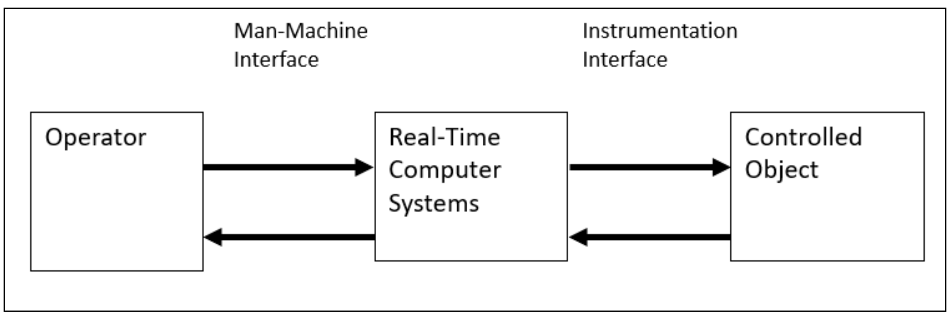
REAL-TIME PROCESS CONTROL FOR DFLAW

TEDS ID: PTW-54 Continued

ADDITIONAL TECHNICAL INFORMATION

The U.S Department of Energy, Office of River Protection (ORP) Waste Treatment and Immobilization Plant (WTP) Strategic Initiative is a three-phase program with ORP directing resources through to the end of Phase 2, FY 2016 to FY 2020/21.

This TEDS sheet describes ongoing activities sponsored by ORP at WTP. The corresponding tank farm activity is addressed in MTW-76. Coordination efforts are made to beneficially capitalize on resources, establish test parameters and share test results to support these efforts.



Real-Time System Probe

COST AND SCHEDULE SUMMARY

WBS: Currently funded under ORP IEWO.

Project or Activity	FY20				FY21				FY22				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Task 1	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	▮	$7,000K-$8,000K
Funding in thousands (000s)	$1,000				$2,000-$3,000				$3,000				$7,000K-$8,000K

RISKS AND OPPORTUNITIES

Risk: 222SL-0009-T 222-S Laboratory Analytical Capabilities Are Exceeded
Opportunity to provide real-time process control that minimizes the time between measurement data acquisition and process evaluation.

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CHEMICAL PROCESS MODELING SOFTWARE TO SUPPORT DFLAW OPERATIONS

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Design and develop dynamic chemical process modeling capabilities to aid operational flow sheeting of TSCR, ETF and WTP operations. Includes software tools to support DFLAW WFD operations such as spreadsheets to track dynamic contents of tank AP-106 during TSCR and WTP operations and to calculate maximum TSCR ion exchange column cesium loading capabilities for each feed campaign.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: PTW-55 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

RPP-44491 identifies the need for operational flow sheeting software that is dynamic, uses a rigorous thermodynamic database, is supported commercially and contains an accurate representation of Waste Treatment and Immobilization Plant (WTP) operating logic so that transient behavior is predicted correctly. This has been expanded to include the need for a dynamic chemical process model of tank-side cesium removal (TSCR). Additional software is needed to support waste feed delivery (WFD) operations. The first is a tool that can be used to track the contents of tank AP-106 as pre-treated waste is added from TSCR and removed by WTP simultaneously. The second is a tool for calculation of the maximum cesium loading that TSCR is capable of for each feed campaign.

TECHNOLOGY SOLUTION

Development of the gPROMS WTP Model began in earnest after the release of the Operation Readiness Evaluation. A usable model exists today, including modifications to the facility for direct-feed low-activity waste (DFLAW) operations and the addition of the Effluent Management Facility (EMF). Updates are under way to make the model more robust and to shift it from a planning tool (24590-WTP-RPT-PT-02-005, *Flowsheet, Bases, Assumptions, and Requirements*) to an operations tool, based on operational strategies.

Development of the gPROMS TSCR and Effluent Treatment Facility (ETF) models began in FY 2018. The TSCR model is being updated as the design is completed and operations strategies are developed. Additionally, updates are planned as more information is made available from laboratory experiments involving crystalline silicotitanate (CST) and as lessons learned from Savannah River Site operation of Tank Closure Cesium Removal (TCCR) and their models are released. The ETF model documentation is being completed. The model will be updated as changes to the facility design are chosen and implemented.

Development and documentation of the tank AP-106 tank composition tracking tool and the maximum cesium loading tracking tool are planned for FY 2020.

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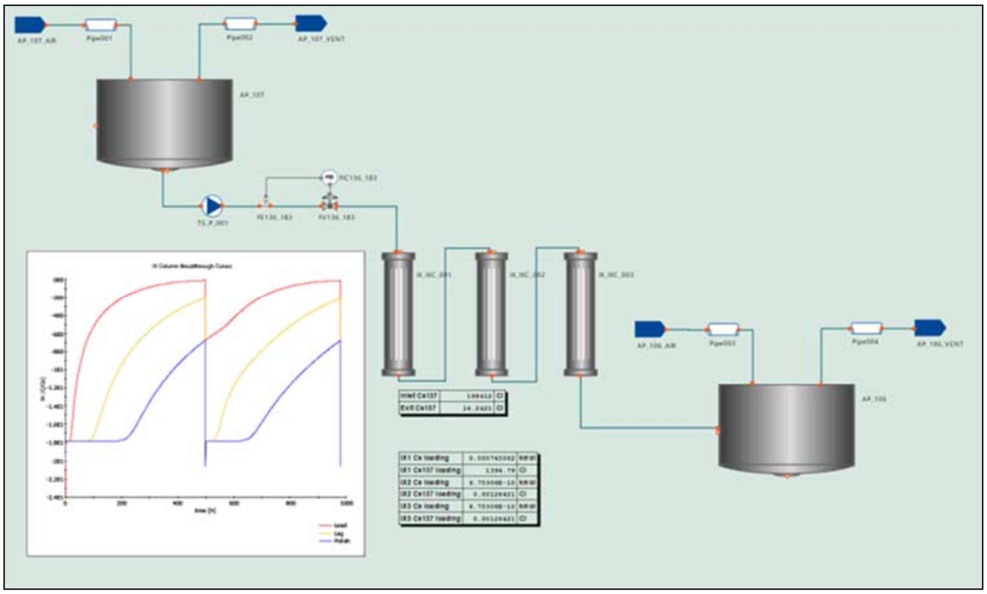
CHEMICAL PROCESS MODELING SOFTWARE TOOLS TO SUPPORT DFLAW OPERATIONS

ADDITIONAL TECHNICAL INFORMATION

TEDS ID: PTW-55 Continued

RPP-4449—*Semi-Annual Waste Treatment and Immobilization Plant (WTP) Operational Readiness Evaluation Report(s) (for October 1, 2009 to March 31, 2010 and April 1 2010 to September 30, 2010. Put this title in additional information*



TSCR Process Schematic Example

COST AND SCHEDULE SUMMARY

WBS numbers: 5.03.07.01.03 and 5.03.01.02.11.03

Project or Activity	FY20				FY21				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
gPROMS TSCR Model Updates	■	■	■	■	■	■	□	□	$215
gPROMS WTP/EMF Model Updates	■	■	■	■	■	■	■	■	$290
gPROMS ETF Model Updates	■	■	■	■	■	■	□	□	$215
AP-106 Tank Composition Tracking Tool	■	■	■	■	□	□	□	□	$140
Maximum Cesium Loading Calculation Tool	■	■	■	■	□	□	□	□	$140
Funding in thousands (000s)	$700				$300				$1,000

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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5.3.2 PTW Catalog Sheets – Unfunded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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ADVANCED DYNAMIC SIMULATION MODELING PLATFORM

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US DEPT OF ENERGY

UNFUNDED

Design and develop a mission level simulation-modeling platform, to replace the G2 platform (upon which Hanford Tank Waste Operations Simulator (HTWOS), TOPSim, and the WTP G2 model are built) and to handle the anticipated influx of modeling requests after the start of DFLAW.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
2-3 Years

TEDS ID: PTW-24 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

ORP requires modeling analysis to support long-term strategic and near-term operational planning, including the System Plan, the Multi Year Operating Plan, Analysis of Alternatives, Tri-Party Agreement negotiations, Double-Shell Tank (DST) Space Plan, Retrieval Plan, and Waste Feed Delivery Plan. Independent management assessment report FY2015-OS-M-0131, *Assessment Report – System Planning Tools and Processes*, concluded that the deficiencies of the current G2-based system represent short-term challenges and long-term risks to the organization, and that it will need to be replaced within 5 to 7 years.

TECHNOLOGY SOLUTION

This technology need centers around designing and implementing additional decision login functionality for replacing the functionality current housed on the G2 platform, with in the long-term modeling to TOPSim. The new software functionality will allow for rapid changes to the River Protection Project mission flowsheet and parametric changes that can be quickly analyzed by the SME for long-term decision making.

By leveraging the Hanford Expedited Planning and Integration Console (Hanford EPIC) as a simulator for near-term tank farm waste transfer activities, long-term decision logic and user interface functionality could be developed to extend the Hanford EPIC modeling capabilities to include the entire mission and allow for quicker turn around of long-term modeling questions and sensitivity studies.

Development of near-term (only) tank farm operations modeling tool Hanford EPIC will be completed in FY 2020 and is being managed and executed by the Mission Integration Analysis organization.

RISKS AND OPPORTUNITIES

Risk: DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

Will not directly impact risk reduction or mitigation directly, but is

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HIGH- TO MID-FIDELITY CONSOLIDATED OPERATORS TRAINING SIMULATOR

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Deploy high- to mid-fidelity consolidated OTS for process monitoring and controls. Use OTS as platform for new process development

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: PTW-26 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

A consolidated operations training simulator (OTS) technology is needed to improve operator proficiencies in running processes such as waste transfers, evaporator runs, exhauster operations and the Low-Activity Waste Pretreatment System (LAWPS).

TECHNOLOGY SOLUTION

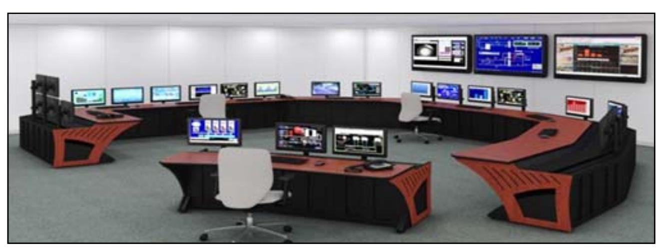
Developing a consolidated high fidelity OTS would provide:

- Increased situational awareness and status control
- Improved response times for upset conditions
- Improved operator environment
- Reduced operating cost
- Encourage excellent and predictable Conduct of Operations
- Reduce unnecessary 'process runs' operations due to training
- Help refine procedures and establishes robust response process.

What's the value of the incident/accident prevented?

- Identify hazards – prevention cheaper than cure
- Control hazards – prevention by preparation
- Perform work – practice makes perfect.

Engineering development may also be achieved by modeling new processes in OTS environment to verify performance and operations. Final process model may then be used as basis for control system development for the new process. OTS platform using J Pro modeling software supports this approach, with established interface to ABB 800xA control system platform. Expansion of existing OTS user base required to take



High-Fidelity OTS

RISKS AND OPPORTUNITIES

Risk WRPSC-0002-T Resources Not Available When Required

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VIRTUAL WORKBENCH FOR WASTE PROCESSING

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US DEPT OF ENERGY

UNFUNDED

Create a VWB workflow using existing tools that simulate waste processing, track data, simulate provenance and provide analysis consistency. Team National Labs and Hanford and Savannah River contractors on integration, tool development. Contractors will lead software development and direct workflow requirements, integrate chemical detail into process flowsheet to address waste acceptance criteria and include waste properties, multiphase flow, and complex plant layouts and processes.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement? Yes

Submitted as Grand Challenge? No

Rough Order of Magnitude Cost & Duration?
~$11 Million, 4 Years

TEDS ID: PTW-39 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

This training simulator could benefit several Grand Challenge topics, such as:

1. Is there a method to remove and store cesium/strontium from the Low-Activity Waste Pretreatment System, temporarily store it and reintroduce it into the Pretreatment Facility or a High-Level Waste Vitrification Facility flowsheet at some point in the future?
2. Is there an economical or innovative method to move waste tank slurry from the more remote single-shell tanks that can operate under today's nuclear safety rules?
3. Is there a sampling and waste acceptance strategy that would simplify the Waste Treatment and Immobilization Plant (WTP) design strategy without significantly impacting throughput or mission life?

TECHNOLOGY SOLUTION

The following describe the virtual workbench (VWB) stages and their associated technical risks.

- **Stage 1, Integration of Existing Software into Advanced Simulation Capability for Environmental Management (ASCEM) Workflow.** Leveraging ASCEM workflow components poses little technical risk as the software infrastructure has been demonstrated as a robust methodology for subsurface simulation.
- **Stage 2, Core Software Replacement: Replacing Hanford Tank Waste Operations Simulator.** Involves technical risk, but careful planning (developing requirements and software design documents) will mitigate this. Year one full project scope, schedule, and cost estimate will also be developed. Software development will completed 5 years prior to WTP operations.
- **Stage 3, Develop New Components for the VWB.** Additional software components may need to be integrated into the workflow to fully represent the waste processing stream.

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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HIGH-LEVEL WASTE PHASED APPROACH

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The current DOE Letter of Direction calls for a phased approach to the startup of River Protection Project faculties and activities. The proposed HLW phased approach builds off of the current DOE strategy by enabling processing HLW solids in the absence of pretreatment.

Technology Maturation Level.
Research and Concepts

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$5-$10 Million
3-4 years

TEDS ID: PTW-40 **Priority: High** **Rank: N/A**

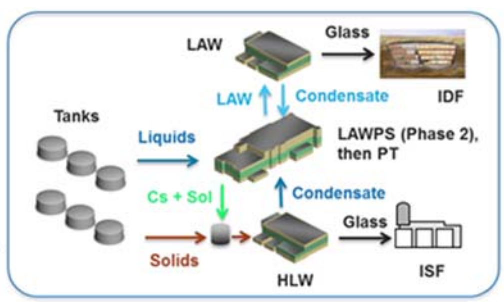
TECHNOLOGY NEED

The current high-level waste (HLW) flowsheet represents a complex, highly coupled system. The proposed direct-feed HLW (DFHLW) simplified flowsheet would less closely couple the Waste Treatment and Immobilization Plant (WTP) and Low-Activity Waste (LAW), HLW, and Pretreatment (PT) Facilities, enabling more process flexibility, more efficient use of facilities, and earlier processing of HLW. These attributes represent an opportunity to avoid or reduce the amount of glass produced, which in turn reduced the mission length and cost of the HLW glass management.

TECHNOLOGY SOLUTION

Studies and planning are required to adequately define the waste acceptance criteria (WAC), update qualification algorithms, gather data to support the design basis, etc. These studies and planning activities are:

- Develop WAC for the HLW Vitrification Facility
- Develop an appropriate set of simulants for testing the DFHLW flowsheet
- Perform laboratory- and engineering-scale demonstrations
- Develop glass property-composition data and models
- Update glass formulation and qualification algorithms for the revised waste feed
- Perform laboratory-scale demonstration of the DFHLW flowsheet with actual waste samples
- Collect data to support design based on design data needs documented in the detailed engineering study.



Direct-Feed HLW

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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HIGH-LEVEL WASTE DIRECT VITRIFICATION – CONDENSATE TREATMENT

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Investigate direct feed of HLW to the WTP, bypassing the PT Facility and enabling early immobilization of HLW. The technology has been demonstrated and successfully implemented at the Savannah River Site.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration
$1-5 Million
2-3 Years

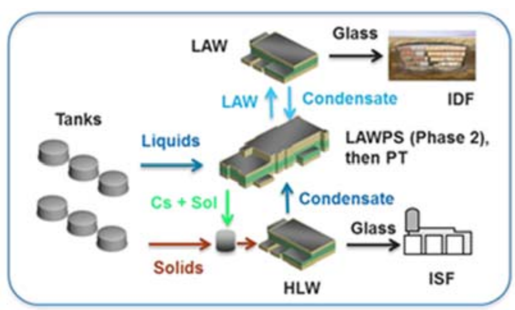
TEDS ID: PTW-42 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Current River Protection Project system models (Hanford Tank Waste Operations Simulator and Hanford Waste Treatment and Immobilization Plant [WTP] Dynamic Flowsheet Model [G2]) show the WTP High-Level Waste (HLW) Facility frequently idling while waiting for waste feed delivery and pretreatment (PT) processes. A key objective of the PT process is to remove a large fraction of the non-radioactive chemical components from the tank waste prior to HLW vitrification to reduce the amount of HLW glass produced and ultimately the project cost. Aluminum and chromium are the two primary insoluble chemical components to be removed from the sludge in the PT process, and their removal requires long cycles of leaching and washing.

TECHNOLOGY SOLUTION

A direct-feed HLW process could be evaluated and potentially adopted as an improved flowsheet for managing Hanford Site tank waste. To enable such a flowsheet, a relatively large solids receipt and mixing vessel (or vessels) would be required near the HLW Vitrification Facility to receive sludge transfers from the tank farms and transfer decant solution back. The soluble components of the waste (e.g., sodium, sulfur) can be removed by using a settle-and-decant process followed by cesium ion exchange to return cesium to the HLW stream, according to the conceptual flowsheet shown.



Direct-Feed HLW

RISKS AND OPPORTUNITIES

DFLAW-0232-T: WTP radioactive dangerous liquid effluent composition

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OPERATIONS PRODUCTIVITY & ANALYSIS TOOLS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

The goal of this project is to demonstrate a novel method of selectively sequestering the pertechnetate (Tc (VII)) ion (TcO_4^-) from radioactive liquid waste by absorbing the water-soluble ^{99}Tc isotope into porous organic frameworks or porous aromatic frameworks with appropriate functional groups.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
$1-$5 Million
3-4 Years

TEDS ID: PTW-45 **Priority: Medium** **Rank: N/A**

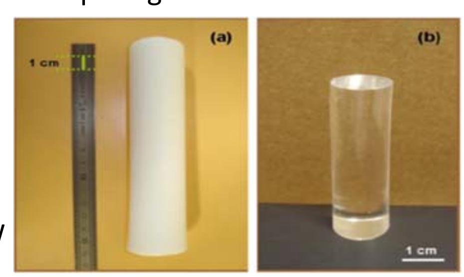
TECHNOLOGY NEED

The efficient capture and immobilization of technetium-99 (^{99}Tc) is a challenge to performance and risk assessment for the Hanford Site because possible contamination levels in ground water are proportional to ~26,500 Ci of ^{99}Tc currently stored in 177 tanks. Based on the current WTP process flow sheets, almost all (i.e., >90%) ^{99}Tc will be present in the liquid LAW that will be sent to the LAW melter. However, a significant fraction of the ^{99}Tc volatizes at high glass-melting temperatures and is captured in the off-gas treatment system. Development of a highly selective and efficient sorbent for the removal of ^{99}Tc from the liquid secondary waste from LAW melter off-gas condensate is needed. In addition, a viable option is needed to immobilize sorbent loaded with 99Tc into a stable waste form.

TECHNOLOGY SOLUTION

The objective of this project is to develop and demonstrate a new class of porous aromatic frameworks (PAFs) that has a high sorption capacity and selectivity for the TcO_4^- from liquid waste, and can be subsequently stabilized in a low-cost cementitious waste form. Our goals are as follows:

1. Synthesize aqueous stable PAF with high density of quaternary ammonium salts
2. Evaluate the TcO_4^- selectivity over other competing anions with batch experiments
3. Develop and evaluate stabilization of the Tc-laden PAF in low-cost cementitious waste form
4. Demonstrate the selectivity and sorption kinetics TcO_4^- from liquid LAW under realistic conditions



Experiments

RISKS AND OPPORTUNITIES

Risk DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

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ADVANCE CH-TRU TANK WASTE TREATMENT TECHNOLOGIES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Synergistic retrieval and treatment / packaging technology is needed to lessen the risk of the current wet retrieval and low-temperature, high-vacuum dryer treatment, while minimizing waste needing returned to DSTs. A less complicated drying system coupled with a mechanical treatment protocol is envisioned.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$5-$10 Million
2-3 Years

TEDS ID: PTW-46 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Preconceptual alternatives report RPP-56063, *Transuranic Tank Waste Project Technology Approach Planning*, was prepared in February 2014 examining multiple technology approaches to treat contact-handled transuranic (CH-TRU) waste from Expressions of Interest from 14 firms. These were binned in five technology areas: retrieval, treatment, packaging, characterization/storage/shipping, and onsite transportation. This report identified pros and cons of the varied approaches, however, its significant value was in identifying the need for overall integration of technologies after down-selection in CD-1. For purposes of this technology development, it is assumed needed only for retrieval and treatment.

TECHNOLOGY SOLUTION

The existing dryer technology needs re-evaluation in concert with a retrieval strategy. A typical mechanical treatment system is shown below. The Washington River Protection Solutions, LLC (WRPS) Engineering organization has conducted (January-February 2018) a Systems Engineering Evaluation effort to narrow down options and coordinate a synergistic approach to include retrieval, packaging and shipment with the treatment technology, improving upon a 2014 study.

Existing Dryer

Mechanical Treatment System

RISKS AND OPPORTUNITIES

Risk DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

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PREVENTION OF HYDROGEN GAS BUILDUP

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

To prevent accumulation of hydrogen gas in the LAWPS/TSCR cesium ion exchange columns, the system is planned to be operated under sufficient back pressure to keep hydrogen in solution.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 years

TEDS ID: PTW-48 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

There has been ongoing discussion around increasing the Low-Activity Waste Pretreatment System (LAWPS) / tank-side cesium removal (TSCR) maximum sodium molarity beyond 6M sodium; however, since hydrogen solubility decreases with increasing sodium molarity and since the existing testing maxed out just over 6M sodium, additional testing will be required at higher sodium molarities to support an increase LAWPS/TSCR sodium molarity waste acceptance. Additionally, further data on hydrogen solubility in waste could provide for further refinement of the current pressure and flow calculations allowing further operational flexibility.

TECHNOLOGY SOLUTION

Would need to be scoped by National Laboratories:

- Identify and develop simulants at molarities above 6M sodium.
- Repeat approach as used in PNL-10785, *Solubilities of Gases in Simulated Tank 241-SY-101 Wastes*, with these new simulants.

RISKS AND OPPORTUNITIES

Risk TFIRR-0045-T DST Tank Failure in East Area
Risk TFIRR-0046-T DST Tank Failure In West Area

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FEASIBILITY OF REMOVING NITRATES FROM THE LAW FEED

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Conduct a study to examine the feasibility of removing nitrates from the LAW feed stream prior to vitrification. The study would evaluate the status and applicability of aqueous-phase nitrate destruction processes for pretreatment of Hanford tank waste with the goal of NOx abatement required for the melter off-gas.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 years

TEDS ID: PTW-49 **Priority: High** **Rank: N/A**

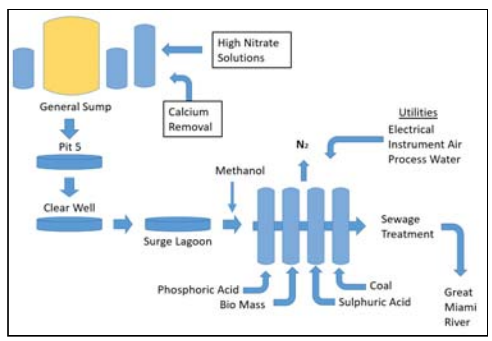
TECHNOLOGY NEED

Nitrates in Hanford Site tank wastes, when processed through the Waste Treatment and Immobilization Plant (WTP), are expected to generate significant amounts of nitrous oxide (NOx) in the vitrification process, necessitating NOx abatement. NOx and ammonia represent the top two chemical hazards in the WTP Low-Activity Waste (LAW) Vitrification Facility. By removing the nitrates in the liquid feed stream before they are fed to the melter, two significant hazards could be substantially mitigated prior to the LAW Vitrification Facility, resulting in potentially no active safety functions within that facility.

TECHNOLOGY NEED

This study evaluates the feasibility status and applicability of aqueous-phase nitrate destruction processes with the goal of substantially reducing the extent of NOX abatement required. Specifically:

1. Assess potential techno-economic benefits of the most promising nitrate destruction method(s).
2. Review current state-of-the-art and historical nitrate destruction technologies applied to high nitrate process wastes and tank wastes.
3. Identify one or more promising process options and process configurations.
4. Develop conceptual process flowsheets for the most promising process options and conduct techno-economic assessments.
5. Identify uncertainties, risks and opportunities associated with the options.



Nitrate Destruction Process

RISKS AND OPPORTUNITIES

Risk

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CHIEF TECHNOLOGY OFFICE

washington river protection solutions

HIGH-LEVEL WASTE SOLIDS SEGREGATION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Address the strict particle size limit by either increasing the limit indicated in ICD-19 by replacing the WTP sampling system or separating particle sizes with a hydrocyclone.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
3-4 Years

TEDS ID: PTW-50 **Priority: Medium** **Rank: N/A**

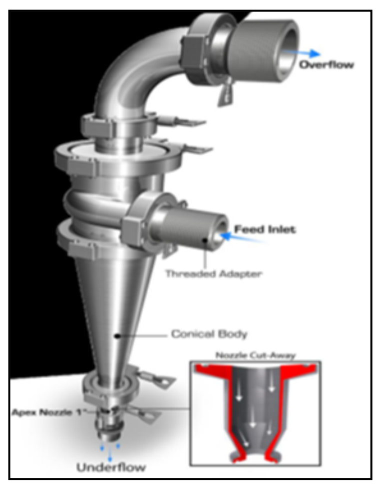
TECHNOLOGY NEED

Simple and reliable technologies are needed to ensure direct-feed high-level waste (DFHLW) feed meets the 310 µm particle size criteria listed in ICD-19, *Interface Control Document for Waste Feed*, as driven by the ASX samplers used by WTP. Additionally, particle density must be limited to 2.94 g/mL in a 1.1g/mL and 2 cP liquid. Needles that would accommodate larger particles would cause damage to the septums in the sample bottles.

TECHNOLOGY SOLUTION

The strict particle size limit is the result of a limitation of the sampling system set in place by WTP. An effective means to lift the restriction may be to install a replacement sampling system that is capable of capturing larger particle sizes. ICD-19 would also need to be changed accordingly to adjust for a larger size limit.

Alternatively, a new process unit will be required to treat the waste to remove larger particles. Hydrocyclones are the most widely used unit operation to size-classify particles in a wet grinding circuit. Hydrocyclones separate particles from a slurry over a range of particle sizes (nominally 5 to 500 µm). Separation is accomplished by feeding a slurry tangentially into the cone shaped hydrocyclone. The rotating flow creates centrifugal forces within the stream and accelerates the settling rate of dense/large particles. The denser/large particles settle to the bottom of the cone and exit in the underflow. The less dense/smaller particles exit the top of the cone in the overflow. The underflow is cycled back into the grinding circuit and the overflow is moved forward for processing.



Hydrocyclone Example

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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NITRITE-HYDROXIDE SOLUBILITY TO DETERMINE ALUMINUM SOLUBILITY IN DFLAW

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

To determine if aluminum will precipitate and foul the direct-feed low-activity waste process, we need solubility interaction factors between all major constituents in the liquid phase with both the aluminate ion and nitrite ion. We are currently missing the nitrite-hydroxide interaction factor.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: PTW-51 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Aluminum precipitation has fouled ion-exchange columns treating Hanford waste (Barton et al. 1986; PNNL-21109). The Savannah River Site has also experienced process problems with aluminum precipitation from supernatants (SRNL-STI-2013-00700). This plugging has occurred because aluminum has precipitated where it was not anticipated. The Flowsheet Maturation Plan (RPP-PLAN-58003) has proposed that a better aluminum solubility model be developed so that aluminum precipitation can be better anticipated. The plan suggests that new solubility data be generated that is specifically target at determining solubility model parameters. The plan indicates that one of the most important solubility model parameters that is currently unavailable is the nitrite-hydroxide liquid phase interaction parameter and indicates that this can be determined by measuring the solubility of sodium nitrite in solutions containing sodium hydroxide over a range of temperatures and hydroxide concentrations. Aluminum precipitation has fouled ion-exchange columns treating Hanford waste (Barton et al. 1986; PNNL-21109). The Savannah River Site has also experienced process problems with aluminum precipitation from supernatants (SRNL-STI-2013-00700).

TECHNOLOGY SOLUTION

The nitrite-hydroxide interaction coefficient can be determined from either solubility data or water activity in mixtures of aqueous solutions of nitrite and hydroxide. It is assumed that this would measure solubility rather than water activity because solubility is conceptually simpler. However, if a laboratory can measure water activity instead, that would work just as well for model parameterization, as long as they can ensure that it is a measure of water activity at equilibrium. To get a statistically significant interaction parameter over the temperature interval of 20 to 85 °C, we need three to four data points over the whole solubility range at least four different temperatures.

RISKS AND OPPORTUNITIES

DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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DFLAW PROCESS OPERATIONAL TROUBLESHOOTING

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Technology solutions are needed to provide the resources and capabilities for rapidly resolving DFLAW operational issues.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost? & Duration?
> $10 Million
3-4 Years

TEDS ID: PTW-53 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Lessons learned from other U.S. Department of Energy (DOE) operations have shown significant delays that resulted in process upsets. To mitigate delays, technologies are needed to provide troubleshooting capabilities and reduce risks to commissioning, startup, and operations. Areas of operational uncertainty include, but are not limited to, waste feed pretreatment, glass former reliability, melter capability, foaming control, offgas treatment, and secondary waste management.

TECHNOLOGY SOLUTION

Technology development required to provide troubleshooting capabilities to mitigate uncertainty include the following:

- **Task 1:** Maintain radioactive and nonradioactive test facilities (i.e., radioactive waste test platform) to support pretreatment filtration and ion exchange, which were developed as part of PTW-38.
- **Task 2:** Provide and maintain melter/headspace and offgas treatment train (e.g., submerged bed scrubber, wet electrostatic precipitator, other elements) testing capability to gain operational assurance. This equipment should allow for rapid troubleshooting of startup and operational problems.
- **Task 3:** Evaluate the need for and develop testing facilities to manage secondary waste formulation and handling.
- **Task 4:** Identify and evaluate direct-feed low-activity waste (DFLAW) process issues and conduct testing to determine mitigation strategy (e.g., foam control).
- **Task 5:** Identify and evaluate DFLAW mechanical issues and conduct testing to determine mitigation strategy (e.g., agitator).

RISKS AND OPPORTUNITIES

Opportunity to provide means that enable resolution of operational issues.

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5.4 Manage Waste

Hanford Site waste immobilization processes will generate secondary waste byproducts in addition to canistered waste forms. Safe, effective disposal paths must be provided for these secondary waste by-products. The appropriate disposal path will be determined based on the nature of the waste type (i.e., LSW or SSW).

SSW may be disposed using a variety of different methods, depending on the type, size, and level of contamination of the waste.

SSWs (i.e., radioactive solid wastes) are non-liquid waste debris and byproducts of Hanford Site operations. The different SSW types include miscellaneous failed equipment, filters; debris; spent IX media; failed LAW melters; LAW melter consumables (e.g., bubblers, thermocouples); and glass residues, among others. Some SSW may be treated on or offsite and is planned to primarily be disposed of at the IDF.

The WTP HLW and LAW Facilities will convert radioactive wastes into glass. Vitrification is a high-temperature process. As a result of WTP vitrification, a portion of the volatile species in the waste (e.g., fluorides, chlorides, some radionuclides [technetium]) will partition to the off-gas system and become part of the LSW streams. In the DFLAW configuration, LAW vitrification will generate off-gas condensates that will be concentrated by evaporation at the EMF. The concentrate will be recycled through the LAW melters to ensure that 99% of the volatiles are modified. EMF condensate must be processed through the Hanford Site ETF.

Technetium management is necessary to facilitate LSW disposal. Long-lived radionuclide technetium-99 is a fission product from nuclear reactors. Approximately 26,000 Ci of predominantly soluble technetium remains within the tank farms that will be processed as LAW. The primary chemical form of technetium-99 found in LAW is the pertechnetate anion (TcO_4^-), with a +7 oxidation state. Pertechnetate will not be removed from the aqueous waste during pretreatment. The compound will be immobilized in the LAW glass (though volatile at high temperatures), or in macro encapsulated SSW, all of which will be disposed at the IDF. Due to a long half-life and high mobility, technetium-99 has the potential to be a major dose contributor in the IDF performance assessment (PA). While the impact of technetium-99 on IDF performance will not be known until completion of updates to the PA, sufficient risk to satisfying the performance standards may warrant a technetium management program.

The treatment of LAW must provide for the removal of cesium. The baseline strategy will remove cesium by IX with crystalline silicotitanate (CST).

The final disposition of spent LAW and HLW melters has not yet been determined (ORP-11242). The alternatives evaluated (DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*) assume that the spent HLW melters will be packaged in an overpack and stored at the interim Hanford storage area until they can be removed for disposition and final disposal. For planning purposes, the final disposition of the LAW melters is assumed to be at the IDF to maintain consistency with the current performance measurement baseline.

The MW function includes the following focus areas:

1. Liquid Effluent Retention Facility (LERF) / ETF – The low radioactivity LSW output stream (evaporator overheads) will be transferred to the LERF for treatment at ETF. However, the ETF currently treats wastes from a number of sources on the Hanford Site. LSW feed streams will include the following:
   - MW disposal trench leachate
   - IDF leachates
   - 242-A Evaporator condensates
   - Laboratory wastewaters and other miscellaneous minor aqueous streams
   - WTP Pretreatment evaporator overheads, caustic scrubber solutions, and other miscellaneous LSW.
2. SSW – These wastes (i.e., radioactive solid wastes) are non-liquid waste debris and byproducts of Hanford Site operations.
3. LSW – As a result of WTP vitrification, a portion of the volatile species in the waste (e.g., fluorides, chlorides, some radionuclides [technetium]) will partition to the off-gas system and the concentrated condensate (via EMF) will become incorporated into the waste glass via recycle through the melters.
4. Technetium Management – The technetium management effort evaluates and guides the options for reducing the amount of secondary waste technetium-99 disposed at the IDF.
5. Cesium Management – The treatment of LAW must provide for the removal of cesium.
6. Melter Disposal – Assumed that spent HLW melters will be packaged in an overpack and stored at the interim Hanford storage area until they can be removed for disposition and final disposal. For planning purposes, the final disposition of the LAW melters is assumed to be at the IDF to maintain consistency with the current performance measurement baseline.

Sections 5.4.1 and 5.4.2 include the catalog sheets for the funded and unfunded technologies, respectively, that fall under the MW function.

5.4.1 MW Catalog Sheets – Funded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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AMMONIA VAPOR MITIGATION

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Investigate potential solutions to mitigate ammonia vapor release from liquid secondary waste.

TEDS ID: MW-02 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Solidification of Effluent Treatment Facility (ETF) liquid secondary waste is being pursued in conjunction with the planning for direct-feed low-activity waste (DFLAW). Prior testing with simulants identified that ammonia vapor release during grouting is substantial for streams with high dissolved ammonia content. The Notice of Construction permit for the prior ETF solidification project had an allowable ammonia release of 2 lb/hr. Mass balance projections indicate that actual releases could greatly exceed this level. The potential waste treatment vendor could benefit from options to deal with this issue.

TECHNOLOGY SOLUTION

Experiments are being conducted to formulate a grout mixture and to design processing and handling equipment. Work is being completed at laboratory and engineering scales with simulant and real waste.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Laboratory Set Up

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AMMONIA VAPOR MITIGATION

TEDS ID: MW-02 Continued

ADDITIONAL TECHNICAL INFORMATION

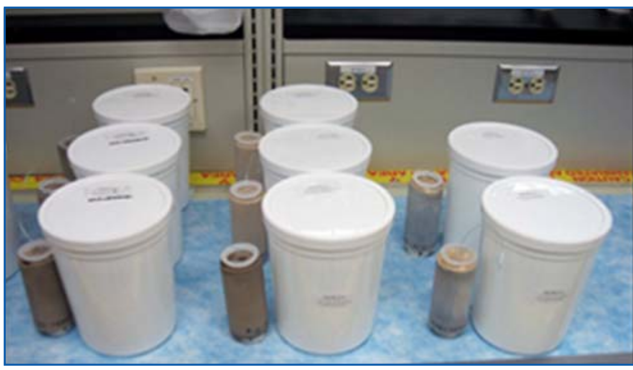
References:

RPP-RPT-31077, *Effluent Treatment Facility Waste Stream Monolith Testing Phase II*

Letter dated June 6, 2007, "Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Addition the 200 Area Effluent Treatment Facility Solidification Treatment Unit"

RPP-51790, *Secondary Liquid Waste Treatment Cast Stone Technology Development Plan*

SVF-2389, SVF-2389 ETF Mass Balance Model v 0.0.xlsm.



Grout Samples Curing

COST AND SCHEDULE SUMMARY

WBS numbers: 5.3.10.3.2.7

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Formulation Development and Testing	■	■	■	■	□	□	□	□	$1,350
Engineering Scale Demonstration	□	□	□	□	■	■	□	□	$575
Funnding In Thousands (000s) Per Year	$337	$337	$338	$338	$287	$288	$0	$0	$1,925

RISKS AND OPPORTUNITIES

Risk DFLAW-232-R, Secondary Liquid Waste Management LTA

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5.4.2 MW Catalog Sheets – Unfunded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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REMOTELY OPERATED OR AUTOMATED ETF INTERNAL CLEANING DEVICE

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A means is needed to clean the ETF process tanks interior walls and roofs without manned entry.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MW-10 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

The Effluent Treatment Facility (ETF) process tanks build up scale that cannot be removed by soaking or recirculating with chemicals. This provides a mechanism for accelerated corrosion and inhibits Resource Conservation and Recovery Act (RCRA)-required tank integrity inspections. The ETF secondary waste process tanks are considered at risk and currently included for replacement in conceptual planning for ETF upgrades to support direct feed low-activity waste (DFLAW) operation. Adequate tank cleaning will allow for a full assessment of the tanks to support replacement for ETF DFLAW treatment readiness or replacement delay based ongoing assessment. A functional cleaning technology will mitigate operational impacts and risks of implementing more aggressive manual cleaning techniques including manned tank entries. Cleaning reduces the risk of tank failure by helping to control pitting.

TECHNOLOGY SOLUTION

ETF needs a method of cleaning scale from process tank interiors that cannot be cleaned by soaking or recirculating with suitable chemicals. The cleaning device should be deployable through a 30-in. tank top manway in congested area and operated remotely or automatically. Manned entries into the tank are not an acceptable option. The tanks have bottom drains and range up to 15 ft wide by 20 ft high.

ETF

RISKS AND OPPORTUNITIES

Risk ETFOP-0043-T ETF Secondary Waste Receiving Tank Failure

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CHIEF TECHNOLOGY OFFICE

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UPGRADE SOLID WASTE INFORMATION & TRACKING SYSTEM

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Technology development for software upgrades to accommodate identification and tracking of WTP solid secondary waste that can be disposed at the IDF.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MW-12 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Regulations require waste to be tracked and managed. The Solid Waste Information and Tracking System (SWITS) is currently used by all contractors to track and manage waste. SWITS needs to be upgraded to handle the waste generated by the Waste Treatment and Immobilization Plant (WTP).

TECHNOLOGY SOLUTION

SWITS is used site wide and the tracking software for managing waste containers. If it is to be used at WTP it will have to be upgraded to include WTP specific items. To do this will require the participation of SWITS maintenance contractor. Also, the Central Plateau contractor (CP) will operate the Integrated Disposal Facility (IDF). The CP will need to decide what program to use for track waste into and out of the IDF. If they decide not to use SWITS, then this is not an issue.

Reference:
WAC 173-303, "Dangerous Waste Regulations"

SWITS Database Menu

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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TRANSPORTATION REQUIREMENTS FOR NEW EQUIPMENT DISPOSAL

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Proposed technology is unknown. It will depend on what waste or samples Waste Treatment and Immobilization Plant plans to ship during its lifetime. A waste shipping container is needed. If the plant plans to ship highly radioactive, very large, or heavy items it will need to have a package designed and built.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: MW-13 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Ensure that transportation requirements are addressed in the development of new equipment. Any equipment developed (i.e., Waste Treatment and Immobilization Plant melters and bubblers) will, at some point, need to be replaced and disposed of. An appropriate waste package is needed to enable transportation to disposal. Sampling methods need to be considered. Waste sampling methods will confirm proper waste packaging and sample transportation per applicable regulations.

TECHNOLOGY SOLUTION

Identify unique equipment or samples that need to be taken and ensure a transportation package exists for that item. Examples are tank waste samples larger than 1 liter or high-dose high-curie large equipment.

RISKS AND OPPORTUNITIES

Risk DFLAW-0357-T: Spent/Failed LAW Melter disposal capability not available when needed

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AT-TANK TECHNETIUM AND IODINE REMOVAL & DISPOSITION

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Fabricate and test ion exchange resins tuned to selectively retain technetium and iodine using a monolithic column configuration for deployment at-tank.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
$1–$5 Million
2-3 Years

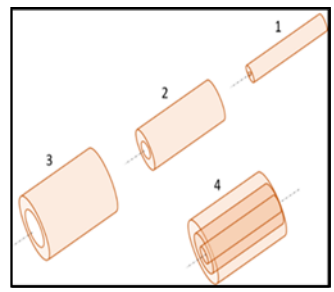
TEDS ID: MW-15 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

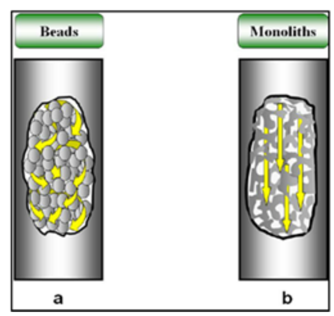
Tc-99 and I-129 are long-lived, highly mobile radionuclides that form species which are volatile at glass melting temperatures. They will likely be a component in the Waste Treatment and Immobilization Plant (WTP) offgas treatment system secondary wastes unless removed prior to entering the glass melter. Removing Tc-99 and I-129 from offgas secondary wastes would remove potentially problem contaminants from the Integrated Disposal Facility waste inventory and protect the Columbia River.

TECHNOLOGY SOLUTION

Work is needed to develop, mature, and deploy technology for "tunable" Tc- and I-selective ion exchange (IX) resins. Monolithic columns create a "single large particle" that fills the column entirely as a continuous skeleton with a series of connected pores that allow no void. The monolithic column develops a network of channels in the continuous phase of a porous material that shows high axial permeability, a large internal pore surface area and less back pressure than that of conventional packed columns. The monolithic column figure depicts three preparation steps. Different parameters can be applied to control porous properties. These include polymerization temperature, the choice of pore-forming solvent or porogen, the type and amount of crosslinking monomers and polymerization time.



Monolithic Column



Conventional (a) and Monolithic (b) IX Column Cut-Aways Showing Resins.

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

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5.5 Dispose Tank Waste

Disposal is the ultimate goal for Hanford Site tank waste. The method of treatment, final waste form characteristics, and type of waste form will determine how and where the waste can be disposed. LSW effluents will be treated at the Effluent Treatment Facility (ETF) and disposed at a permitted land disposal site. ETF secondary solid waste (SSW) will be disposed at the Integrated Disposal Facility (IDF). Immobilized LAW (ILAW) and potentially supplemental LAW will be disposed of at the IDF. Immobilized HLW (IHLW) will be interim-stored onsite and ultimately disposed at an as-yet undetermined geologic repository. CH-TRU waste is planned to be disposed at the Waste Isolation Pilot Plant (WIPP). There are other relatively benign wastes (e.g., submerged bed scrubber condensates) that may be treated offsite and disposed at commercial waste disposal facilities. The Test Bed Initiative is captured in Revision 5 of this Roadmap.

The DTW function includes the following focus areas to assess potential offsite disposal of LLW in a grouted waste form:

1. IDF – The IDF is located on the Hanford Site in 200 East Area and is the designated disposal location for ILAW. The facility consists of a single landfill with two expandable cells for extra capacity. The cells use a double-lined system with leachate collection, detection, and removal capability.
2. IHLW Interim Storage – The path forward for IHLW interim storage entails sequential construction of potentially several modular facilities. One or more facilities will be provided as necessary to furnish IHLW interim storage capacity.
3. WIPP – The WIPP is the nation's underground disposal facility for DOE TRU solid waste. Hanford Site ships legacy TRU waste to WIPP as part of the CH2MHILL Plateau Remediation Company program to disposition solid waste landfills.
4. Offsite Disposition – Offsite disposition refers to both offsite treatment and disposal of Hanford tank liquid and/or related solid waste.
5. Offsite Transportation – Offsite transportation refers to future transportation systems needed for shipping Hanford waste (liquid and/or solid) to offsite treatment and/or disposal facilities. This effort supports offsite disposition by developing shipping transportation systems for material transport.

Sections 5.5.1 and 5.5.2 include the catalog sheets for the funded and unfunded technologies, respectively, that fall under the DTW function.

5.5.1 DTW Catalog Sheets – Funded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

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LOW TEMPERATURE WASTE FORM PROCESS

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Develop and qualify a low-temperature waste form for supplemental immobilization of LAW. A low temperature immobilization process would be significantly less complex to design, construct and operate than a high-temperature vitrification process. Estimates indicate that low temperature processing will reduce capital and operating costs by 7 and 3 times, respectively. A further benefit could be realized if a single grout facility is used to immobilize both LAW and secondary wastes.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: DTW-02 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

The Waste Treatment and Immobilization Plant (WTP) Project is designing and building a vitrification facility for immobilizing Hanford Site low-activity waste (LAW) in a glass waste form. However, the LAW Vitrification Facility has limited capacity and will only be able to treat about one-third of the total LAW within the mission duration timeframe (bounded for high-level waste [HLW] treatment). Additional LAW immobilization capacity is needed for timely completion of the waste treatment mission and to avoid protracted interruptions of the HLW Vitrification Facility operations. Low temperature supplemental LAW treatment (i.e., grout) could provide the needed capacity. However, waste form performance data for grouted LAW are needed for both a supplement analysis to the Tank Closure and Waste Management Environmental Impact Statement to construct and operate the facility and process, and for the Integrated Disposal Facility Performance Assessment, to allow ultimate disposal of the waste form. Technology maturation activities are also needed to support a future U.S. Department of Energy (DOE) Record of Decision on what process to use for supplemental immobilization of Hanford LAW.

TECHNOLOGY SOLUTION

The development approach is described in a Technology Maturation Plan that is patterned after the DOE/EM 413.1-4, *Technology Readiness Assessment (TRA)/Technology Maturation Plan (TMP) Process Implementation Guide*, technology maturation process and embodies a phased approach to mature the technology over multiple fiscal years. The logical progression of the technology development work includes formulation development, testing to support long-term performance projections for the performance assessment, engineering-scale integrated testing, and waste form qualification testing.

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LOW TEMPERATURE WASTE FORM PROCESS

TEDS ID: DTW-02 Continued

ADDITIONAL TECHNICAL INFORMATION

Close Up of Monoliths on Stands Prior to Leaching

Monolith Leach Container During Leach Testing

COST AND SCHEDULE SUMMARY

WBS number: 5.3.12.2.2

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Techlogy Needs Assessment	■	■	■	■					$900
Develop strategies and tools or "Sample and Send"				■	■	■	■	■	$550
Screen "Capture and Hold" Technologies					■	■	■	■	$650
Develop strategy for Nitrate Retention	■	■	■	■	□	□	□	□	$350
Funnding In Thousands (000s) Per Year	$900				$1,550				$2,450

RISKS AND OPPORTUNITIES

Risk DFLAW-363-R, WTP LAW Throughput is LTA

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ILAW GLASS TESTING FOR IDF PA SUPPORT

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Perform engineering and laboratory tests to characterize immobilized LAW glass to support the IDF PA update and future maintenance.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: DTW-03 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

The Waste Treatment and Immobilization Plant (WTP) Project is designing and building a vitrification facility for immobilizing Hanford Site low-activity waste (LAW) in a glass waste form. Immobilized waste from the LAW Vitrification Facility, starting with direct-feed LAW (DFLAW) processing, will be disposed of onsite in the Integrated Disposal Facility (IDF). Waste form performance data are needed to support the IDF Performance Assessment (PA) (RPP-RPT-59958) and PA maintenance to permit and operate the IDF. Work performed in FY 2017 and FY 2018 supported improvements in waste loading and processing. Additional work is need to clarify long-term glass dissolution rates for enhanced glasses. The near-term risk associated with not performing this work is the necessity to restrict the IDF PA analysis to lower waste loading in baseline glasses than might be achievable with the enhanced glasses. Long-term risks includes the potential for higher operating costs for LAW immobilization and IDF disposal caused by the need for lower throughput to maintain lower waste loading in the glass and the subsequent generation of a greater volume of waste for disposal.

TECHNOLOGY SOLUTION

The 2017 IDF PA performed analysis using baseline glasses. However, recent work is being completed to develop new LAW glasses that can achieve higher waste loadings. The hope is to integrate the new glass formulations into DFLAW operations immediately after DFLAW LAW Pretreatment System commissioning. To implement enhanced glass formulation, testing data on the short- and long-term dissolution rate of the new glasses. This information will be needed to support PA analysis of the fate of the enhanced glasses in the IDF and their potential impact on the environment. It is likely the PA analysis will be performed immediately prior to startup of DFLAW.

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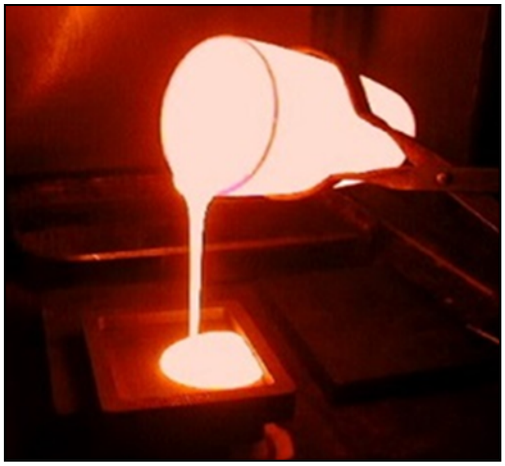
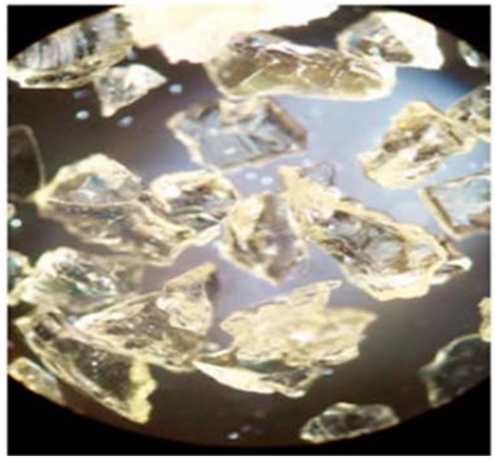
ILAW GLASS TESTING FOR IDF PA SUPPORT

TEDS ID: DTW-03 Continued

ADDITIONAL TECHNICAL INFORMATION



Immobilized LAW Glass Sample Formation



Ground Glass Samples Used in Dissolution Rate Tests

COST AND SCHEDULE SUMMARY

WBS number: 5.03.06.01.04.05

Project or Activity	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Actual Waste Testing	■								$184
Engineering Scale Integrated	■	■	■	■					$730
Long Term Performnace-PA Support	■	■	■	■					$730
Supplemental LAW: Develop strategies, tools, and the flowsheet necessary to implement a "Sample and Send"					■	■			$350
Supplemental LAW: Evaluate synergistic capture and hold technologies for technetium and iodine					■	■	■	■	$350
Supplemental LAW: Screen ability of engineered barriers and bulk waste					■	■	■	■	$650
Funding In Thousands (000s) Per Year	$1,644				$1,350				$2,994

RISKS AND OPPORTUNITIES

Risk DFLAW-0052-T, IDF Performance Assessment Delay

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CHIEF TECHNOLOGY OFFICE

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SOLIDIFICATION & STABILIZATION OF SOLID SECONDARY WASTE

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Development and maturation of a technology for the solidification and stabilization of solid secondary waste form by macro or micro-encapsulation with grout.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

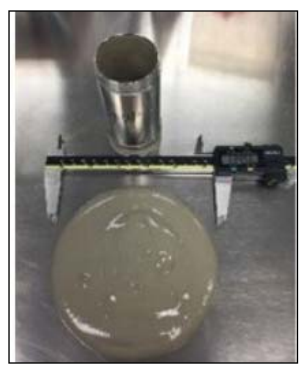
TEDS ID: DTW-07 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

During direct-feed low-activity waste (DFLAW) operations, radioactive secondary solid waste (SSW) will be generated at the waste processing facilities. Such wastes are expected to include used process equipment, contaminated tools and instruments, decontamination wastes, high-efficiency particulate air filters (HEPA), carbon adsorption beds, iodine sorbent beds and spent ion exchange resins. SSW treatment processes and waste forms will be needed in time to support DFLAW operations. Accordingly, these waste forms have been included and analyzed as part of the 2017 Integrated Disposal Facility (IDF) Performance Assessment (PA) (RPP-RPT-59958). In FY 2016, information available from published literature was reviewed, surveyed and compiled in a data package for the 2017 IDF PA. Development and testing activities to collect data on Hanford Site SSW was started in FY 2017. Data and results of waste form development and testing of grouted Hanford SSW form will be used in the upcoming PA maintenance and in the design and operation of any treatment capability that may be needed to support the disposal of SSW in the IDF.

TECHNOLOGY SOLUTION

Work scope priorities are based on the results of the 2017 IDF PA analysis, which indicated that there are four major SSW forms that can have significant inventory of contaminants of concern when disposed in the IDF. Those major SSW forms are spherical resorcinol formaldehyde (sRF) resin, HEPA filters, carbon bed adsorbers and silver mordenite. This work will employing a variety of standard laboratory-scale tests to measure physical and chemical properties of grout/waste form formulations. The findings will then be assessed with anticipated IDF disposal requirements to identify waste forms and processing methods for producing SSW disposal packages. Work will be accomplished in four phases:



Samples During Formulation Development

(1) Formulation Development
(2) Waste Form Fabrication and Qualification/Characterization,
(3) Waste Form Performance Testing, and
(4) Scale-Up or Engineering Scale Testing.

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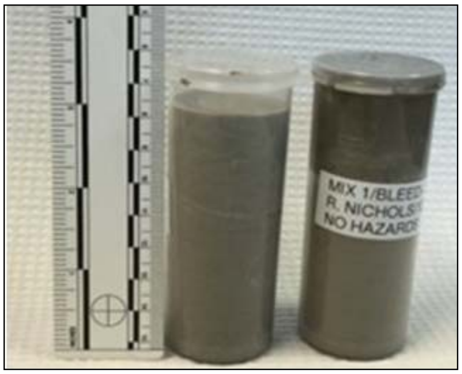
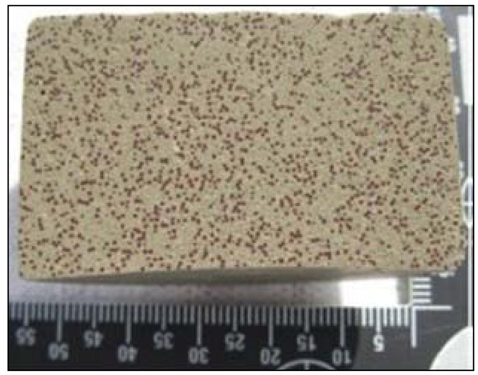
SOLIDIFICATION & STABILIZATION OF SOLID SECONDARY WASTE

TEDS ID: DTW-07 Continued

ADDITIONAL TECHNICAL INFORMATION



Grout Flow Testing of Encapsulation Grout



sRF Resin Grout

COST AND SCHEDULE SUMMARY

WBS number: 5.3.12.2.4

Project or Activity	FY20				FY21				FY22				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Leach Test of Encapsulation Grout	■	■	■	■	□	□	□	□	□	□	□	□	$245
Development and testing of Waste Form 1 (HEPA Filter)	■	■	■	■	□	□	□	□	□	□	□	□	$245
Development and testing of Waste Form 2 (sRF Resin)	■	■	■	■	□	□	□	□	□	□	□	□	$245
Development and testing of Waste Form 3 (Silver Mordenite)	■	■	■	■	■	■	□	□	□	□	□	□	$615
Development and testing of Waste Form 4 (Carbon Bed Adsorber)	□	□	■	■	■	■	■	■	■	■	□	□	$1,950
Funding in thousands (000s)	$1,100				$1,100				$1,100				$3,300

RISKS AND OPPORTUNITIES

Risk DFLAW-0206-T, Secondary Solid Waste Management LTA (Tank Farms and WTP)

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CHIEF TECHNOLOGY OFFICE

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IDF LONG-TERM LYSIMETER DATA STUDY

HANFORD SITE
US DEPT OF ENERGY

FUNDED

Validation of PA models using field results from monitored and well-understood lysimeter tests are needed to improve stakeholder confidence in IDF and waste form performance. Increased understanding can allow modelers to better understand how well the model predicts IDF conditions and could allow reduced conservatism in release estimates, resulting in better utilization of the IDF and lower closure requirements and costs.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

TEDS ID: DTW-08 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

A long-term study of low-activity waste (LAW) form degradation using the Field Lysimeter Test Facility (FLTF) on the Hanford Site will:

1. Provide field experimental data on degradation of various waste forms.
2. Be used to refine process model descriptions of contaminant (source term) release from the waste forms.
3. Reduce uncertainties about the representativeness of laboratory testing results for determining long-term waste form performance under field conditions.
4. Improve confidence in the IDF PA (RPP-RPT-59958) by providing data that verify parameters and assumptions used in the PA modeling.
5. Determine potentially important impacts from co-disposal of the glass and cementitious waste forms;
6. Determine changes in the physical (e.g., structural properties) and chemical (e.g., secondary phase formation, reducing capacity, leach rate) properties of the glass and cementitious waste forms during interaction with surrounding materials to improve long-term predictions of waste form performance.
7. Identify relevant secondary phases that are formed during waste form alteration in the lysimeter to improve long-term predictions of waste form performance.

TECHNOLOGY SOLUTION

Develop a test plan covering waste forms, surface-to-volume ratios, precipitation and other parameters which influence waste form durability and are key inputs to performance assessment models such as STOMP and GoldSim. Focus will be on cementitious waste forms but glass will be included. Laboratory and field work will include:

1. Loading the lysimeters and monitor parameters needed as input and to validate models.
2. Systematically retrieving samples, analyze them, and compare results to models ran to simulate sample/lysimeter history; including analysis for secondary phases.

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IDF LONG-TERM LYSIMETER DATA STUDY

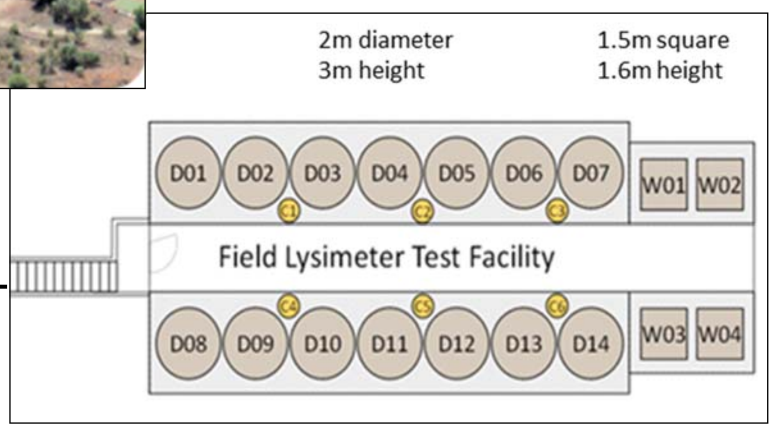
TEDS ID: DTW-08 Continued

ADDITIONAL TECHNICAL INFORMATION

Reference:

PNNL-27394, *Field-Scale Lysimeter Studies of Low-Activity Waste Form Degradation*

Aerial FLTF Location View. FLTF has 14 Primary and 4 Weight Monitoring Lysimeters



FLTF Schematic

COST AND SCHEDULE SUMMARY

WBS number: 5.03.06.01.04

Project or Activity	FY20 Q1	FY20 Q2	FY20 Q3	FY20 Q4	FY21 Q1	FY21 Q2	FY21 Q3	FY21 Q4	Totals
Task Lysimeter Setup and Monitoring 2	■	■	■	■	□	□	□	□	$1,793
Ongoing Monitoring	□	□	□	□	■	■	■	■	$493
Funding in thousands (000s)	$1,793				$493				$2,286

RISKS AND OPPORTUNITIES

Risk DFLAW-0052-T, IDF Performance Assessment Delay

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TEST BED INITIATIVE PHASE 2

HANFORD SITE
US DEPT OF ENERGY

FUNDED

TBI 2 is being executed to demonstrate tank waste treatment producing LLW that can be immobilized and disposed of in a commercial facility.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

TEDS ID: DTW-10 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

The U.S. Department of Energy (DOE) is evaluating potential alternate waste disposal options such as those available at the Waste Control Specialists (WCS) Federal Waste Facility (FWF) in Texas. The WCS FWF allows for the disposal of commercially treated and immobilized low-level waste (LLW) that meets the facility's waste acceptance criteria. In support of this evaluation, the DOE Office of Environmental Management (EM) is conducting a 2,000-gallon Test Bed Initiative Phase 2 (TBI 2) to demonstrate the feasibility of options for retrieval and treatment of waste at the Hanford Site.

TECHNOLOGY SOLUTION

Washington River Protection Solutions, LLC (WRPS) is supporting the TBI 2 initiative by performing the installation, operation and shipment of the treated waste to the immobilization facility. The solution under implementation includes design, fabrication and testing of the TBI 2 system by an offsite team. Initial design of the system is currently under way. This system is anticipated to include a pump, filter, ion exchange column, monitoring system and totes to receive the treated waste. WRPS is supporting the initiative by performing the installation, operation and shipment of the treated waste to the immobilization facility. No performance testing beyond a factory acceptance check is planned for the TBI 2 system prior to deployment and operation. After immobilization by others, the LLW will be shipped to the WCS FWF.

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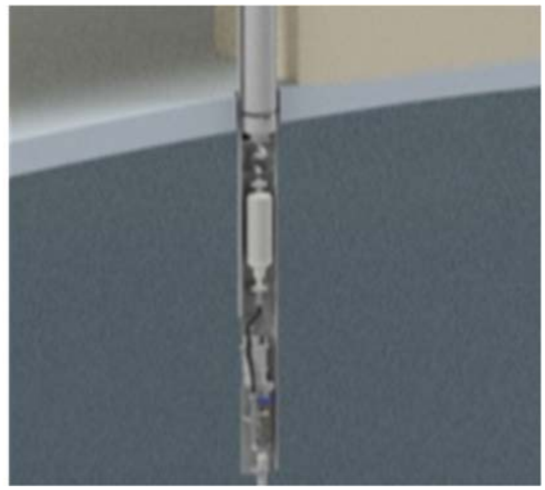
TEST BED INITIATIVE PHASE 2

TEDS ID: DTW-10 Continued

ADDITIONAL TECHNICAL INFORMATION

Tank Farm TBI 2 Waste Retrieval



TBI 2 Waste Tank Pump

COST AND SCHEDULE SUMMARY

WBS numbers: 5.03.12.02.09.01, 5.03.12.02.09.03, and 5.03.12.02.09.04

TBI Phase 2	FY20				FY21				Total
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Restart-Project Support		■	■	■	□	□	□	□	$127,472
Restart-Equipment Removal				■	□	□	□	□	$132,898
Restart-Environmental Support		■	■	■	□	□	□	□	$260,370
Restart-Safety Support					□	□	□	□	$0
Funding In Thousands (000s) Per Year	$520,740				$0				$520,740

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T, WTP LAW Throughput is LTA

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5.5.2 DTW Catalog Sheets – Unfunded

Note: *Parentheticals following catalog sheet titles denote priority High (H), Medium (M), or Low (L).*

CHIEF TECHNOLOGY OFFICE

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ADVANCE OFFSITE TRANSPORTATION CAPABILITY

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Advance the technology to ship large quantities of radioactive and mixed liquid waste offsite for treatment and/or disposal.

Technology Maturation Level
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: DTW-06 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

This effort advances the capability to ship large-quantity radioactive and mixed liquid waste offsite for treatment and/or disposal. The shipment of small-quantity liquid waste and all solid waste offsite is very mature, except for spent melters. There is currently no baseline or lifecycle planning associated with shipment of large quantity liquid waste off the Hanford Site. This technology development would only be needed should a strategic planning scenario for offsite treatment/disposal of tank waste in liquid form be implemented. Implementation of a revised offsite shipment strategy would require the design and fabrication of new shipping casks to meet mature transportation criteria (i.e., criteria from the U.S. Nuclear Regulatory Commission, U.S. Department of Transportation and U.S. Department of Energy).

TECHNOLOGY NEED

Establish criteria to procure a new shipping container to meet regulatory requirements for large-quantity shipment (no technology development). Procure new certified shipping container (no technology development except for potential National Laboratory involvement in the certification testing). Develop technology for interface/transportation of the new shipping container (technology development involved in this effort).

Transporter

RISKS AND OPPORTUNITIES

Risk DFLAW-0357-T, Spent/Failed LAW Melter Disposal Capability Not Available When Needed

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CHIEF TECHNOLOGY OFFICE

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INTEGRATED DISPOSAL FACILITY RISK BUDGET TOOL MONITORING

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Technology is needed that would accurately verify waste inventory (radionuclide inventory) and physical characteristics of containers (external dose, heat, etc.) for containers coming into the IDF.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost? & Duration?
$1-$5 Million
0-2 Years

TEDS ID: DTW-11 **Priority: High** **Rank: N/A**

TECHNOLOGY NEED

Software development is needed to allow the waste generator to accurately input radionuclide and chemical inventory data directly into the Waste Management Information System (WMIS) and have the software verify the data input is within the limits of the waste profile. This need applies to both immobilized low-activity waste (LAW) glass and secondary waste streams.

TECHNOLOGY SOLUTION

Provide a software to more accurately track radionuclide, chemical inventory and physical properties of the containers to efficiently manage the disposal of LAW in the Integrated Disposal Facility (IDF). This technology solution must interface with WMIS to more effectively manage the IDF waste acceptance process.

LAW Canister

IDF

RISKS AND OPPORTUNITIES

Risk: DFLAW-0052-T: IDF Performance Assessment delay.

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CHIEF TECHNOLOGY OFFICE

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EVALUATION OF NATURAL ANALOGUES TO SUPPORT TAILORED GROUT

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Grout can be tailored to enhance durability when amended with phases intended to sequester specific troublesome radionuclides such as technetium and Iodine-129. Many of those phases are analogues to natural minerals which are inherently stable. This activity would evaluate the natural analogue data to show that tailored grouts could be more durable than glass for key risk-driving radionuclides.

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: DTW-12 **Priority: Medium** **Rank: N/A**

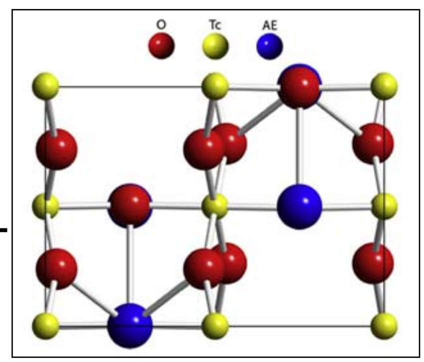
TECHNOLOGY NEED

Develop and qualify a tailored grout waste form for supplemental immobilization of Hanford low-activity waste (LAW). This waste form is needed to sequester specific troublesome radionuclides such as technetium and iodone-129.

TECHNOLOGY SOLUTION

This technology development phase will be a literature review on the geological stability of various solid phases in arid environments. This should show that (1) pyrochlore, goethite, hematite and potentially magnetite are geologically stable and (2) natural analogues for the grout/matrix phases (e.g. layered hydroxides, tobermoreite) that have shown capability to exchange anions over time, can also bind contaminants. The initial focus would be on phases that sequester technetium and iodine. Follow-on technology development phases will include tailored grout formulation testing.

Model of technetium Incorporation in $SrTcO_3$



RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T, WTP LAW Throughput is LTA

Opportunity, some of the potential additions to tailored grouts are iron (hydroxides), which have natural analogues to soils. Iron oxides are stable in soils for millions of years, as evidenced by the fact that they are present in soils that are millions of years old.

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CHIEF TECHNOLOGY OFFICE

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LONG-TERM DURABILITY OF CEMENTITIOUS WASTE FORMS

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

Long-term durability of cementitious materials is uncertain and should be evaluated through examination of ancient manmade and natural materials.

Technology Maturation Level
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
2-3 Years

TEDS ID: DTW-13 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Long-term durability of cementitious waste forms is an uncertainty that affects the regulatory approval of these materials for low-activity waste. Fresh waste forms may meet disposal requirements; however, regulators often are skeptical that cementitious waste forms will remain intact rather than crumble, thereby increasing the diffusive transport area. Increases in transport area directly increase the rate that waste products are released from the solid waste form.

TECHNOLOGY SOLUTION

Collect and analyze information on natural and anthropogenic ancient cement materials to quantify the stability of the underlying crystalline structures and macro properties.

Example of Ancient Concrete from the Roman Empire

Pozzolan (Volcanic Ash) Deposits in Southern California

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T, WTP LAW Throughput is LTA

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COMPLEX-WIDE DATABASE FOR CEMENTITIOUS WASTE FORM PROPERTIES

HANFORD SITE
US DEPT OF ENERGY

UNFUNDED

A central electronic repository for experimental results, technology reports and lessons learned associated with development and application of cementitious waste forms for radioactive wastes is needed to facilitate the use of the most up-to-date information in decision making. It should be made accessible across the DOE complex through a web-based interface that facilitates locating, searching and retrieving information.

Technology Maturation Level
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge
No

Rough Order of Magnitude Cost & Duration?
< $1 Million
0-2 Years

TEDS ID: DTW-14 **Priority: Medium** **Rank: N/A**

TECHNOLOGY NEED

Multiple U.S. Department of Energy (DOE) laboratories and contractors are developing cementitious formulations for solidifying a variety of liquid and solid wastes. This information is not well organized or distributed and the best information is often not incorporated into decision documents such as performance assessments. A central repository for this information along with a web accessible database interface is needed to facilitate access.

TECHNOLOGY SOLUTION

This need can be met by working with both the experts developing and testing cementitious waste forms, and those who are developing and maintaining performance assessments to:

1. Identify the data needs and presentation formats that is most advantageous to the data users.
2. Determine what information and associated metadata is considered a high priority by the data users.
3. Collect, annotate, catalog and store experimental results, technical reports and lessons learned associated with developing and disposing of cementitious waste forms.
4. Code and promulgate a web interface within the DOE complex to make the information available.

RISKS AND OPPORTUNITIES

Risk DFLAW-0363-T, WTP LAW Throughput is LTA

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6.0 TECHNOLOGY DEVELOPMENT FUNDING

WRPS partners with the DOE National Laboratory network, academia, and industry experts to develop innovative approaches to enhance our ability to meet the mission needs. This section details technology development funding.

WRPS prioritizes technology development tasks annually. Funded tasks seek to increase safety, improve efficiency, and minimize life cycle costs associated with completing the TOC mission. This section details the following:

- Technology development program funding
- National Laboratory support to funded programs
- National Laboratory, academia, and supplier/contractor support distribution.

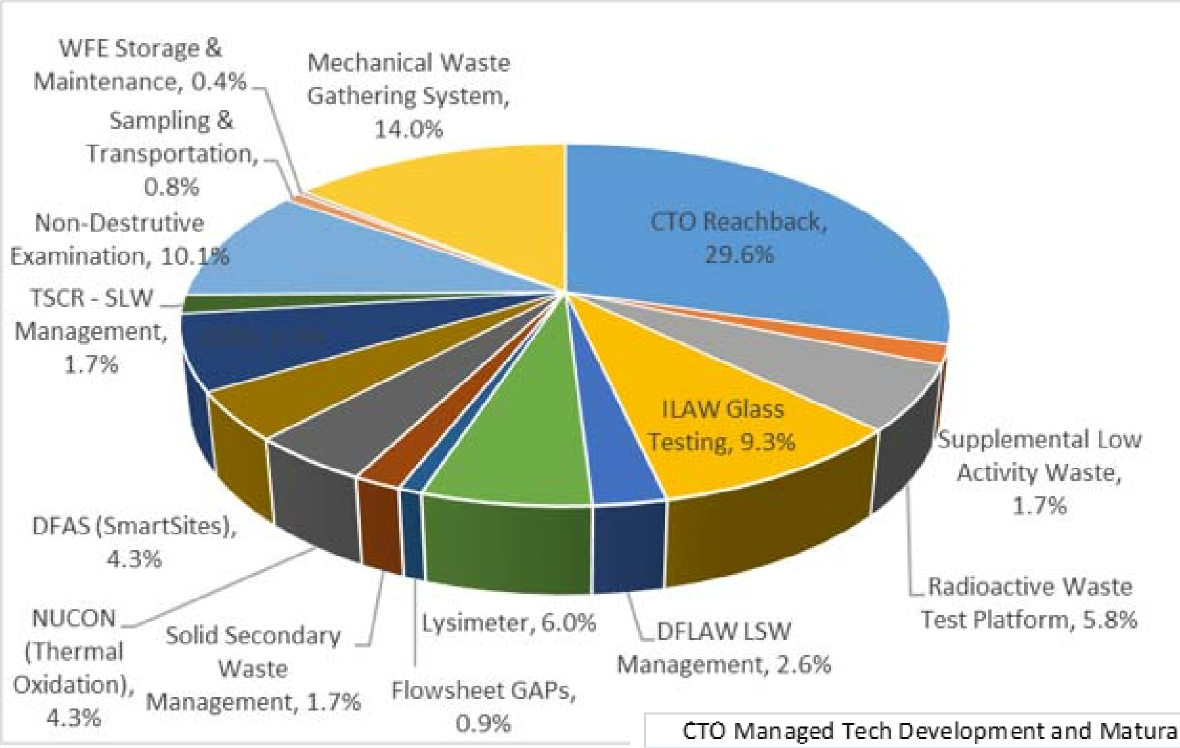
Efforts are made to evaluate all work scope and utilize the appropriate laboratory to support the project based on the laboratory capabilities and past experience. For FY 2020, National Laboratory support is being provided by Pacific Northwest National Laboratory (PNNL) and Savannah River National Laboratory (SRNL). The FY 2020 funded tasks are shown in Figure 6-1. The figure shows the total funding along with individual program funding levels expressed in dollars and depicted in a pie chart as percentages. During FY 2020, technology development funding will be invested in CTO Reachback (29.6%), Mechanical Waste Gathering System (14.0%), and ILAW Glass (9.3%), among other projects.

In addition to the National Laboratory network, investments in technology were also made with the academic institution VSL. Development activities, supported by the National Laboratories are shown in Figure 6-2. National Laboratories expertise is being utilized in these development programs. National Laboratory support funding distribution for these technology development programs is shown in Figure 6-2. The figure shows the total funding and individual program funding levels expressed in dollars and depicted in a pie chart as percentages. The majority of this funding contributes to DFLAW Maturation (36.3%), Vapors (17.7%), and Operational Support (17.7%).

In addition to National Laboratory and academia institution support, WRPS is also teaming with commercial suppliers/contractors, such as Atkins. There are seven suppliers under contract to provide technology development support. PNNL receives 38.0% of the support and Atkins receives 14.9% as the dominant supplier. A complete list of teaming suppliers is shown in Figure 6-3. The figure shows the total overall funding as well as the funding percentage distribution.

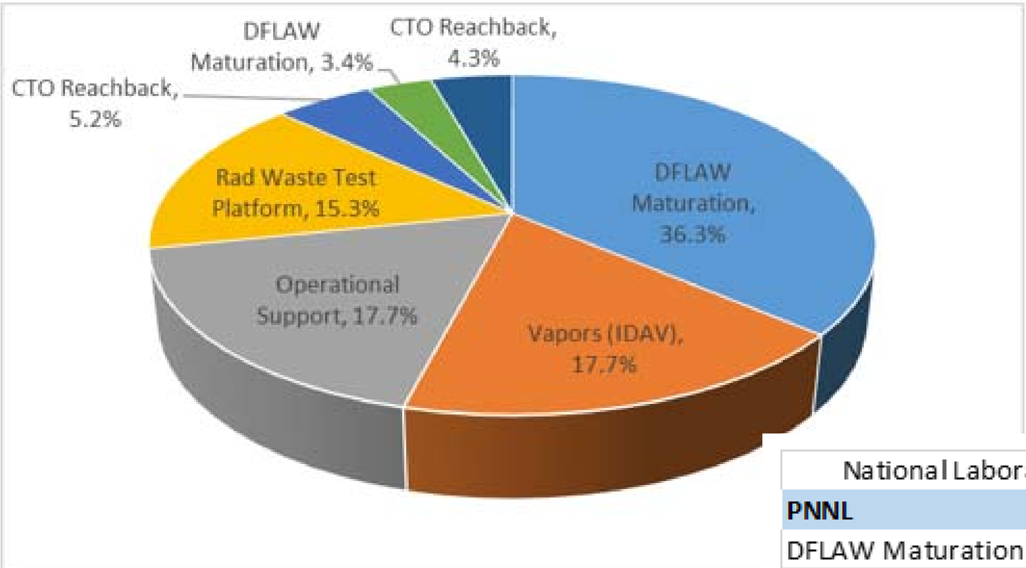
Technology development funding is provided primarily by the CTO. Some funding is provided by other tank farm organizations such as Tank & Pipe Integrity (MTW-73), Project Office (MTW-83), and Closure & Interim Measures (RTW-34).

Figure 6-1. CTO-Managed Technology Development and Maturation Scope.



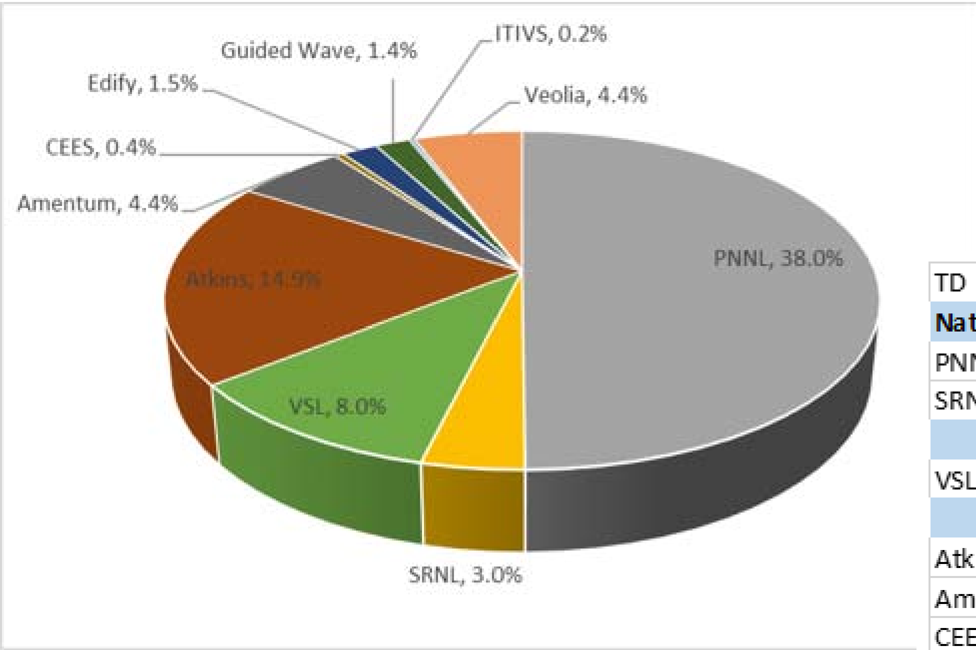
CTO Managed Tech Development and Maturation Scope			
CTO Reachback			
CTO Reachback	$	6,807	29.6%
Total	$	6,807	29.6%
SLAW			
Supplemental Low Activity Waste	$	391	1.7%
Total	$	391	1.7%
DFLAW Maturation			
Radioactive Waste Test Platform	$	1,340	5.8%
ILAW Glass Testing	$	2,138	9.3%
DFLAW LSW Management	$	599	2.6%
Lysimeter	$	1,386	6.0%
Flowsheet GAPs	$	197	0.9%
Solid Secondary Waste Management	$	396	1.7%
Total	$	6,056	26.3%
Vapors			
NUCON (Thermal Oxidation)	$	993	4.3%
DFAS (SmartSites)	$	996	4.3%
IDAV	$	1,550	6.7%
Total	$	3,539	15.4%
LAWPS/TSCR			
TSCR - SLW Management	$	385	1.7%
Total	$	385	1.7%
Operation Support			
Non-Destrutive Examination	$	2,330	10.1%
Sampling & Transportation	$	183	0.8%
WFE Storage & Maintenance	$	84	0.4%
Total	$	2,597	11.3%
Retrievals			
Mechanical Waste Gathering System	$	3,208	14.0%
Total	$	3,208	14.0%

Figure 6-2. National Laboratory Support.



National Laboratory Support			
PNNL			
DFLAW Maturation	$	3,179	36.3%
Vapors (IDAV)	$	1,550	17.7%
Operational Support	$	1,546	17.7%
Rad Waste Test Platform	$	1,340	15.3%
CTO Reachback	$	459	5.2%
Total	$	8,074	92.2%
SRNL			
DFLAW Maturation	$	300	3.4%
CTO Reachback	$	380	4.3%
Total	$	680	7.8%

Figure 6-3. Technology Development Funding Distribution.



TD Funding Distribution	
National Laboratory Support	
PNNL	38.0%
SRNL	3.0%
Academia	
VSL	8.0%
Suppliers	
Atkins	14.9%
Amentum	4.4%
CEES	0.4%
Edify	1.5%
Guided Wave	1.4%
ITIVS	0.2%
Veolia	4.4%

7.0 SUMMARY AND CONCLUSIONS

ORP is responsible for managing and completing the RPP mission, which comprises both the Hanford Site tank farms operations and the WTP. The RPP mission is to accomplish the following:

- Safeguard and safely manage over 54 Mgal of nuclear waste stored in Hanford tanks
- Treat the waste
- Achieve safe waste disposition to protect the Columbia River and the environment.

To reduce the risk and cost associated with these objectives, DOE implements new technologies. The identification of these technologies comes from a variety of sources, collected and prioritized in this Roadmap. The informational inputs and outputs of the Roadmap are identified in Figure 3-1.

7.1 Summary

The Roadmap catalogs ideas for evaluation for each of the TOC process or functional areas. These ideas capture specific issues and potential approaches involving the development of new technology or innovative application of existing technology to accelerate risk reduction and lower life cycle costs. This information is intended to support the FY planning and National Laboratory contracting processes to ensure that RPP mission technology needs are supported as necessary. In addition, the Roadmap provides a basis for strategic planning by identifying opportunities to use technology solutions to enhance mission efficiency.

7.2 Conclusions

An extensive revision of the Roadmap occurs annually. The revision is developed in a systematic manner to facilitate sound strategic, programmatic, and fiscal planning regarding existing technology gaps in the RPP mission. Each year expert personnel are solicited for input from each of the five functional areas of the RPP flowsheet. Input is provided in standardized TEDS format to ensure consistent reporting.

Based on TEDS input, the technology needs may be tied to projects or require development. As the RPP mission consists of many interwoven, interdependent unit operations, a technology gap or need in an upstream unit operation can cause impacts throughout many functional areas. The Roadmap reconciles individual technology development activities and combine efforts where possible. This process has been enabled in large part due to efforts of National Laboratory testing and development to meet the growing needs of Hanford to safely dispose of the stored waste.

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APPENDIX A

TECHNOLOGY ELEMENT DESCRIPTION SUMMARY AND CATALOG SHEET FORMS

A.1 INTRODUCTION

Technology Element Description Summary (TEDS) sheet and Catalog sheet comparison.

The following forms represent the TEDS sheets (Figures A-1 and A-2) and the catalog sheets for a ***funded technology*** (Figures A-3 and A-4), and catalog sheets for an ***unfunded technology*** (Figure A-5).

As discussed in Section 3.1, the TEDS sheets are populated by the technology requester ("prepared by") who is knowledgeable regarding the need (or want) and possibly the proposed solution. The requester is not obligated to propose a solution to the stated technology need but is welcome to submit possible solutions or concepts through the TEDS process. The requester also provides cost/funding and schedule information as appropriate. The TEDS sheet is then used to generate the catalog sheet which further summarizes the technology development process being proposed and/or a status of ongoing progress . The blank catalog sheets (i.e., Figures A-3 through A-5) are to indicate the information cross-walk between the TEDS sheet and the catalog sheet.

Figure A-1. TEDS Form, Page 1.

Technology Element Description Summary

input for the Technology Roadmap

The Technology Roadmap (RPP-PLAN-43988) is scoped to address the technology needs of the Office of River Protection (ORP) and assist with mission planning. To facilitate development of the document, the Chief Technology Office is coordinating with ORP and its contractors to identify and prioritize technology needs. This Technology Element Description Summary worksheet is a tool for documenting that information.

Identification #:	FA-##	**Prepared By:**	First Name Last Name
Revision Number:	0, 1, 2, ... etc.	**Contractor POC:**	First Name Last Name
Submittal Date:	Click here to enter	**DOE-ORP POC:**	First Name Last Name

1. Technology Title

A few words to describe the technology

2. Technology Summary

Provide a FEW sentences summarizing the need and proposed technology.

3. Priority Ranking

Click to select

High: technology needed within 1-4 yrs, or ORP-identified strategic need
Medium: technology needed within 5-10 yrs
Low: technology needed >10 yrs

4. Baseline Status

Click to select

5. Functional Area

(check the box that best describes the technology functional area)

Manage Tank Waste (MTW)	Retrieve Tank Waste (RTW)	Process Tank Waste (PTW)	Manage Waste (MW)	Dispose Tank Waste (DTW)
☐Tank Farm Ops ☐Vapor Programs ☐Infrastructure Upgrades ☐242-A Evaporator ☐222-S Laboratory ☐Sampling & Transport ☐other: specify	☐Retrievals ☐DST Transfers ☐Cross-Site Transfers ☐DST Upgrades ☐Feed Preparation ☐Tank Closure ☐other: specify	☐LAWPS ☐EMF ☐WTP LAW Vitrification ☐WTP HLW Vitrification ☐WTP Pretreatment ☐TWCS ☐CH-TRU ☐other: specify (e.g., DFLAW, DFHLW, flowsheets, etc.)	☐LERF/ETF ☐Secondary Solid Waste ☐Secondary Liquid Waste ☐Tc Management ☐Cs Management ☐Melter Disposal ☐other: specify	☐IDF ☐IHLW Interim Storage ☐WIPP ☐Off-Site Disposition ☐Off-Site Transport ☐other: specify

6. Grand Challenge

Was this technology submitted as a Grand Challenge? Click for yes/no

If yes, what year? Click for year Title? Title of Grand Challenge

7. Technology Impact and Risk Identification

(choose one)

☐ A) Risk Mitigation
☐ B) Opportunity
☐ C) Mission Need

If you answered A or B on the left, fill out this section:

Does this technology address a risk identified in a Risk Register? (if unsure, contact your Risk SME) Click for yes/no

Risk ID number(s): Risk ID

Handling action(s)?: Click for yes/no

Additional space here to describe the risk, opportunity, or mission need. If there are known handling actions associated with the Risk IDs, please list and describe them here.

8. Technology Need

Why is this technology needed? Provide a description of the mission need, requirement, or issue that is driving the proposed technology solution. Point to how the technology will fill the need or gap, mitigate risk, and how it relates to the overall TOC mission. Identify the date when this technology is needed. Identify TPA milestones or impacted projects, if applicable.

Rev. 1 12/14/2017

Figure A-2. TEDS Form, Page 2.

Technology Element Description Summary

input for the Technology Roadmap

9. Technology Solution

Provide a short summary of the proposed solution, what it will do, and how it will be developed (e.g., Task 1, Task 2, Task 3…). If you can, please elaborate on the technical details (if you answered "planned" in Box 4, we expect you to). Pictures, sketches, or conceptual models are always helpful. Insert pictures below by clicking on the picture icon. Please describe the pictures in this text field.

10. Technology Maturation Level

Choose maturation level

Will national laboratory involvement be needed? Click for yes/no

11. Cost and Schedule Summary

If you answered "needed" in Box 4, fill out this section.

ROM overall project cost:

☐ <$1 million ☐ $1-$5 million ☐ $5-10 million ☐ >$10 million

Overall project duration (time to complete project):

☐ 0-2 years ☐ 2-3 years ☐ 3-4 years ☐ 4+ years

If you answered "planned" in Box 4, fill out this section.

Schedule (for additional task description rows, Right Click >> "Insert schedulesum After"):

Project or Activity	Year 1				Year 2				Year 3				Year 4				Totals
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Enter task description	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Funding in thousands (000s)	$				$				$				$				$

WBS number: Add WBS number here.

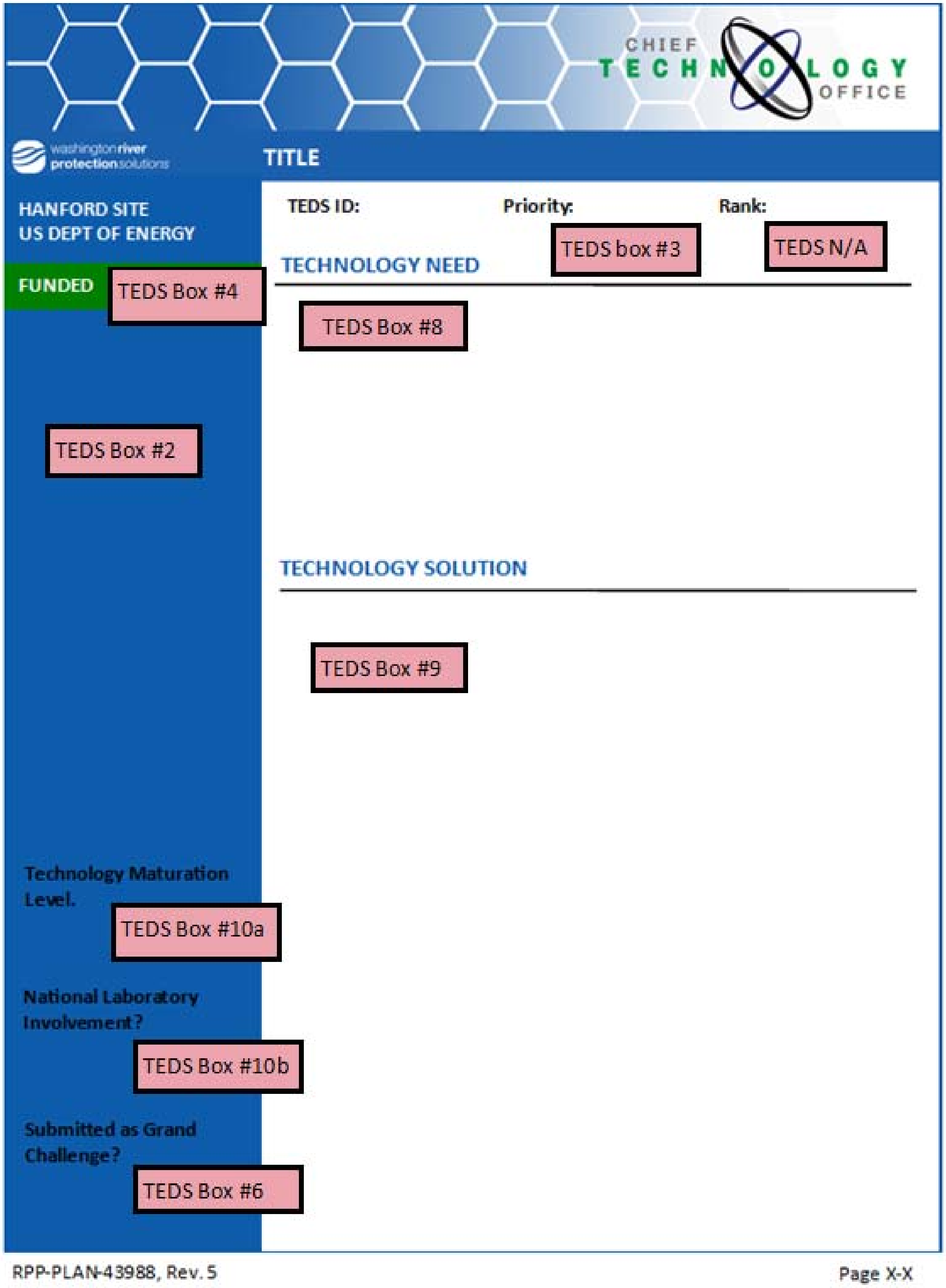
12. References (applicable supporting documentation, e.g. Reports, SOW, Functions and Requirements)

List document references. If the work is currently funded, provide the Scope of Work number.

13. Comments

Add additional comments here.

Figure A-3. Catalog Sheet for Funded Technologies, Page 1.



CHIEF TECHNOLOGY OFFICE

washington river protection solutions

TITLE

HANFORD SITE
US DEPT OF ENERGY

FUNDED TEDS Box #4

TEDS Box #2

TEDS ID: Priority: TEDS box #3 Rank: TEDS N/A

TECHNOLOGY NEED

TEDS Box #8

TECHNOLOGY SOLUTION

TEDS Box #9

Technology Maturation Level.

TEDS Box #10a

National Laboratory Involvement?

TEDS Box #10b

Submitted as Grand Challenge?

TEDS Box #6

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Figure A-4. Catalog Sheet for Funded Technologies, Page 2.

CHIEF TECHNOLOGY OFFICE

washington river protection solutions

TITLE

TEDS ID: ABC -XX continued

ADDITIONAL TECHNICAL INFORMATION

TEDS Box #9

COST AND SCHEDULE SUMMARY

WBS number:

TEDS Box #11

RISKS AND OPPORTUNITIES

TEDS Box #7

Contractor Contact:
Phone:
Email:

TEDS Header

DOE ORP Contact:
Phone:
Email:

TEDS Header

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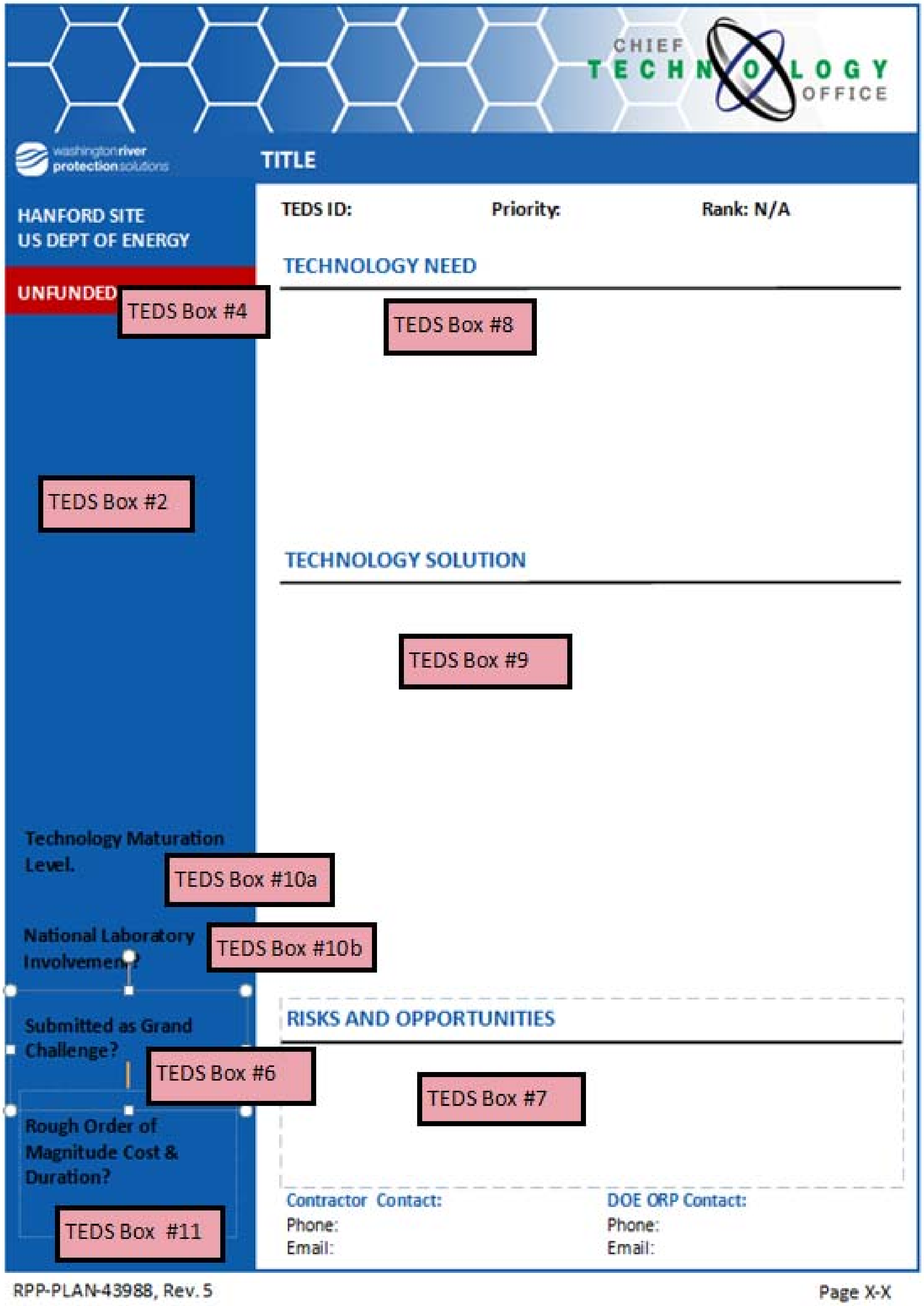
Page X-XX

Figure A-5. Catalog Sheet for Unfunded Technologies.



APPENDIX B

RANKING AND RATING PROCESS

B1.0 Technology Prioritization

There are over 100 technologies detailed in this Roadmap. In order to efficiently develop technologies, an organization has been established. The Chief Technology Office (CTO) employs a two-step process to bring order and create a technology precedence based upon importance. First, representatives from the Tank Operations Contractor and the U.S. Department of Energy (DOE), Richland Operations Office (ORP) use the Technology Element Description Summary (TEDS) information to classify the technology elements into low-, medium-, and high-priority categories. This is based primarily on when the technology is needed to support River Protection Project (RPP) mission requirements. Second, the high-priority technologies are further evaluated and scored numerically in order to create an order of importance. Catalog sheets are then developed to summarize each technology element. The document is compiled and released for use within the DOE complex. Subsequently, TOC and ORP representatives determine the utilization of resources to achieve needed technologies.

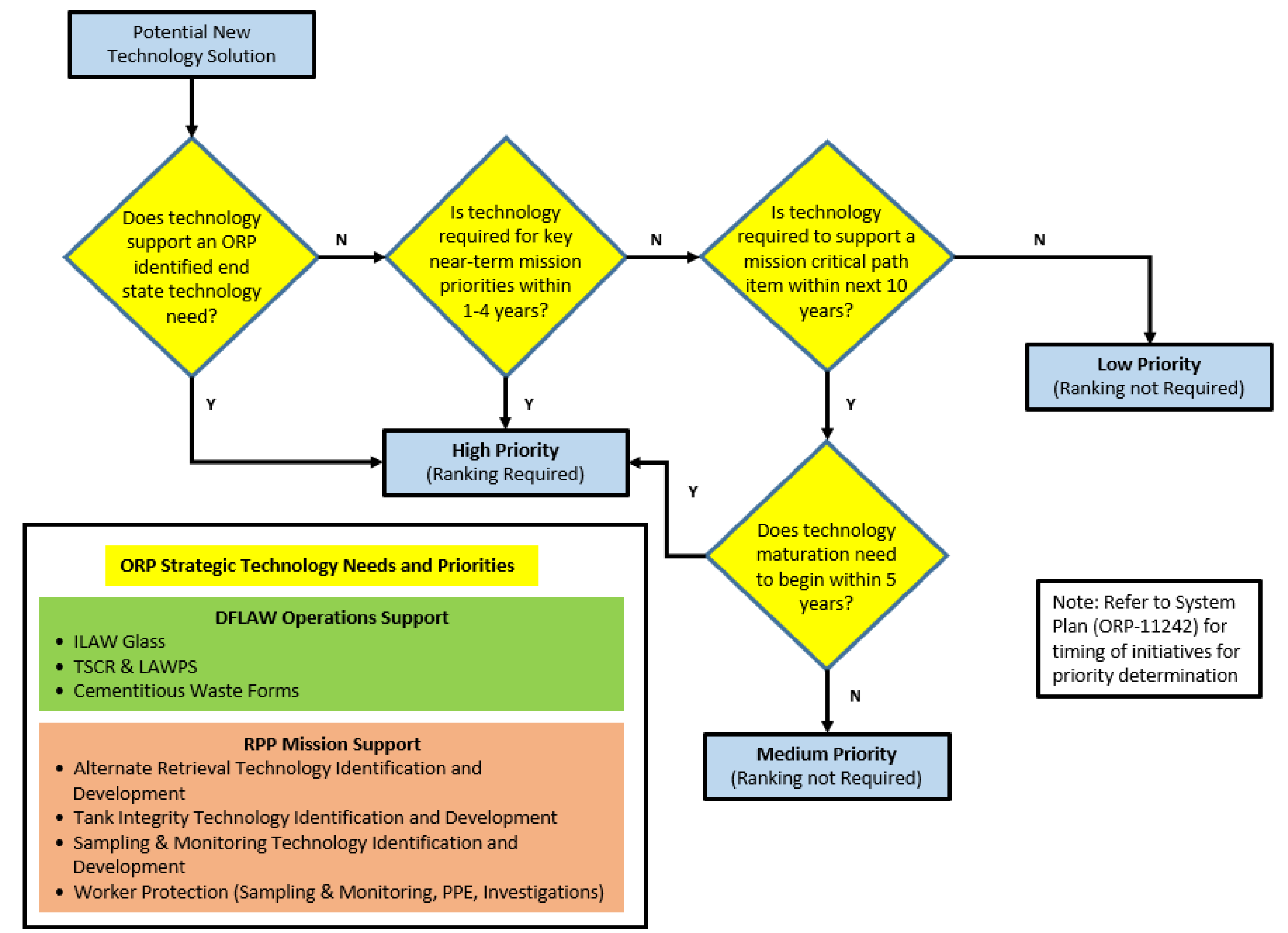
The RPP prioritizes technology development tasks as not all identified technology tasks can be performed concurrently. This is due to limitations of resources and some tasks require development of predecessor activities prior to implementation. A prioritization determination method, depicted in Figure B-1, was established to evaluate and rate the various technology development needs. This is step one. This rating process allows for a transparent approach to identify highest-priority technologies. The ORP strategic technology needs and priorities are identified in the lower left-hand box of Figure B-1. These are considered “need-to-haves.” These priorities (Mission Programs) are depicted in Figure B-1. Green highlighted priorities directly support direct-feed low-activity waste (DFLAW) operations. Orange items support accomplishment of the RPP mission.

Figure B-1 also illustrates the general logic for prescreening and prioritizing TD activities. This is known as the ranking process. This basic diagram guides the prioritization process. The decision process is sequential. It begins with an initial pre-screening to identify the highest-priority technology needs. All technology needs are classified in one of three priority levels: High, Medium, and Low. The priority determination takes into account the timing needs.

Timing refers to supporting near-term (1 to 4 years) mission needs, support a mission critical path item (within 10 years) plus needed to be initiated within 5 years. High priority rankings are determined by considering the ORP end-state priority or the key near-term mission priority of 1 to 4 years. Medium priority determination considers mission critical path item and need to initiate development within 5 years in order to provide support. Low priority items support accomplishment of the RPP mission but do not have any timing criteria.

The prioritization results are documented on both the TEDS form and catalog sheets contained in Section 5.0, Mission Technologies and Innovations.

Figure B-1. Mission-Driven Technology Activity Prioritization Logic.



DFLAW = direct-feed low-activity waste	PPE = personal protective equipment
ILAW = immobilized low-activity waste	RPP = River Protection Project
LAW = Low-Activity Waste Pretreatment System	TSCR = tank-side cesium removal
ORP = U.S. Department of Energy, Office of River Protection	

The urgency of a technology need is related to timing, while the benefit of the solution is related to the magnitude of its contribution to overall mission success. As shown, only high-priority technologies are further evaluated and scored numerically in order to create an order of "importance." This is step two, known as the "rating" process.

Determining the benefit of a technology solution involves ascertaining if the solution addresses a "need-to-have" imperative or a "nice-to-have" addition to support the progress of the RPP mission. In other words, does the technology provide a solution that does not yet exist, but is required to allow completion of the mission? Alternatively, does the technology offer incremental improvement resulting in greater efficiency, cost avoidance, or other benefit?

Table B-1. Scoring Protocols for Priority Determination.

Evaluation Criteria	High (3x weight)			Medium (2x weight)			Low (1x weight)	
	(A) Safety	(B) DOE Commitment	(C) End-State	(D) Risk Mitigation	(E) Schedule Impact	(F) Technology Impact	(G) Implementation Complexity	(H) Mission Enhancement
Gauge for relative criteria score	Reduce specifically identified safety risk?	Contribute to DOE commitment or milestone completion?	Support ORP identified End State TM&E?	Reduce RPP mission or WRPS program and project risk?	Impact near-term schedule?	Multiple applications?	Change existing operating protocols or extend schedule?	Improve or accelerate the mission?
3	Yes	Needed for Consent Decree or DFLAW	Yes, directly supports End State TM&E	Supports mitigation or impacts RPP mission risks	Needed to maintain or recover key RPP mission objectives schedule	Benefits other DOE sites	No, within scope with no delays expected	Implements a specific opportunity that improves mission efficiency
2	Potentially	Needed for TPA, DOE HQ or public commitment	Enhances an End-State but not critical path	Supports risk items that don't impact RPP mission risks	Needed to accelerate key mission objective schedule	Benefits other Hanford projects	Extra time and more schedule activities may be needed	Improves likelihood of mission efficiencies
1	No	No direct impact	No direct impact	N/A or acceptable risk	No impact to key RPP mission objective schedules	Project-specific, WRPS application only	Extra time and more schedule activities will be needed	None identified
Total = 3∑(high criteria scores) + 2∑(medium criteria scores) + 1∑(low criteria scores)								

Consent Decree, 2010, *State of Washington v. DOE, Case No. 08-5085-FVS (October 25), Eastern District of Washington,* as amended.

DFLAW = direct-feed low-activity waste.
DOE = U.S. Department of Energy.
HQ = Headquarters.
N/A = not applicable.
RPP = River Protection Project.
TPA = Tri-Party Agreement.
TM&E = Technology Maturation & Execution
WRPS = Washington River Protection Solutions LLC.

The importance determination process measures the technology activities against a predetermined set of criteria (Table B-1) defined by technology and subject matter expert representatives from each functional area described in Section 3.1. These representatives evaluate, ranks, and rates technology needs. The representatives include one expert from each functional area, plus five additional impartial individuals from ORP, the CTO, One System Mission Planning, Performance Measurement Baseline, and Life-Cycle Baseline who are familiar with the RPP mission scope to facilitate the process.

Each TEDS is prescreened to determine the technology needs that are the considered high priority. Only these prescreened TEDS sheets are further evaluated. A set of evaluation criteria and a scoring protocol are defined to determine relative importance for purposes of guiding out-year technology scope decisions. Results are validated by the functional area leads.

The evaluation criteria are divided into high, medium, and low weighting categories. High weighting is attributed to those technologies that impact safety and compliance with DOE requirements and commitments. Medium weighting is attributed to technologies that mitigate risk, positively impact schedule, and provide technology benefits beyond the identified application. Low weighting is attributed to technologies with technical and RPP mission enhancement benefits.

The scoring process results in a weighted raw score and a whole number score for each item. Some items resulted in the same weighted score and were assigned the same whole number score. A sub-scoring process was applied that further differentiated technologies according to category weight by adding a relative decimal value. To discriminate between a tie, a re-evaluation of the high, medium, and low scores is performed and the sub-importance determined.

As part of the overall scoring evaluation, additional incremental scoring based on the level and extent of the impact for each criterion is also taken into account. The final scoring value is determined according to the summation of the weighted high, medium, and low attributes.

ORP priorities and high priority technologies are depicted in Figure 4-1. The figure shows technology development activity durations and their relationship to mission milestones (diamonds) and operational durations. Technology development activities supporting ORP end-state priorities are detailed. Timing of technology development with DFLAW operations and RPP mission support activities are shown.

B2.0 References

Consent Decree, 2010, *State of Washington v. DOE, Case No. 08-5085-FVS (October 25)*, Eastern District of Washington, as amended.

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APPENDIX C

TECHNOLOGY DEVELOPMENT ACHIEVEMENTS AND TEDS RETIREMENT SUMMARY

C1.0 Introduction

This appendix highlights some of the significant accomplishments the Chief Technology Officer (CTO) has achieved over the past few years. As work has progressed, several Technology Element Description Summary (TEDS) sheets have been "retired." There can be several reasons for retirement, as follows:

- Technology has been implemented
- No longer needed — mission need changed
- New technology exists
- Reclassified as non-technology development
- No technology exists
- Combined with another TEDS
- Deemed unsuccessful, no longer needed
- Overcome by events.

This appendix documents technology development achievements and retired technologies.

C2.0 Recent Technology Development Achievements

These achievements have helped to reduce the Hanford life-cycle cost by providing the most effective technology equipment, materials, and processes. The achievements were reached using research, testing, and analyses. The achievements were enabled by having strong relationships with the National Laboratories, Academia, U.S. Department of Energy (DOE) Office of River Protection (ORP), stakeholders, and technical service providers (suppliers).

TEDS identification has been provided for identified technologies. A couple technology developments have occurred prior to the TEDS development process and have been noted accordingly.

Tank-Side Cesium Removal (TSCR) (PTW-52)

Essential to provide waste feed of the overall direct feed low-activity waste (DFLAW) program mission. The TSCR key objective is to remove undissolved solids and radioactive cesium from double-shell tank (DST) supernatants and feed the treated waste directly to the Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste (LAW) Vitrification Facility for immobilization. This project is the replacement for the LAW Pretreatment System (LAWPS) project. All development to support design, fabrication, testing, and commissioning have been accomplished. Work continues on operational support.

Technology development testing demonstrated successful:

- Full height ion exchange (IX) column performance
- IX testing with Hanford Site waste
- Gas generation rate for key conditions
- Equilibrium contacts for key conditions
- IX media drying rates
- Filtration testing with simulant
- Filtration testing with Hanford waste.

TSCR Testing Demonstration

Continuous Emissions Monitor (CEM) Smart Sampler (MTW-24)

The continuous emissions monitor (CEM) Smart Sampler system was developed to provide a high fidelity, reliable stack monitor for use on Hanford actively ventilated tanks. The system can also provide area and tank headspace-sampling capability. The CEM unit includes real-time multi-gas analysis utilizing an ultra-violet – differential optical absorption spectrometer to detect a handful of important vapor COPC constituents and a flame ionization detector (FID) that determines total volatile organic compounds. In addition, the unit includes a gas chromatograph FID (GC-FID) to allow detection of a large number of chemicals of potential concern (COPCs) every hour and includes an autonomous programmable whole-air grab sampling capability utilizing Summa cans and sorbent tubes. That is, more comprehensive than the existing stack monitoring units. In February 2020, a factory acceptance test was completed.

Technology development accomplishments include:

- Completion of system design
- Equipment procured
- Equipment tested.

CEM Smart Sampler

Fugitive Emissions (MTW-24)

The fugitive emissions (FE) detection technology purpose is the development of an FE identification and characterization program for improved worker safety. The mission benefits for this technology include:

- Potentially decrease the need for high level of personal protection equipment (PPE), thereby improving productivity in tank farms
- Educate workforce on nature of odors detected outside tank farms
- Enhance safety culture awareness for workforce.

AreaRAE

Technology development accomplishments include:

- Procured and installed equipment for odor sampling and analysis
- Conducted investigations around tank farms to establish database of odors to quantify chemical levels to reduce/eliminate hazardous conditions for the workforce
- Developed tools that establish method and process for vapor trail with source characterization.

ToxiRAE Pro

NUCON Thermal Oxidation System (MTW-24)

NUCON International, Inc. has successfully developed a thermal oxidation system (TOS) based on an internal combustion engine. Tests have been underway since early 2017 to determine the destruction removal efficiencies (DREs) for Hanford COPCs using this technology. Progress to date show majority of COPCs destroyed. The mission benefits of this technology are:

- Minimize on-going ops through better emissions management
- Improves worker environment vapor control
- Enhances safety culture awareness for the workforce.

Technology development accomplishments include:

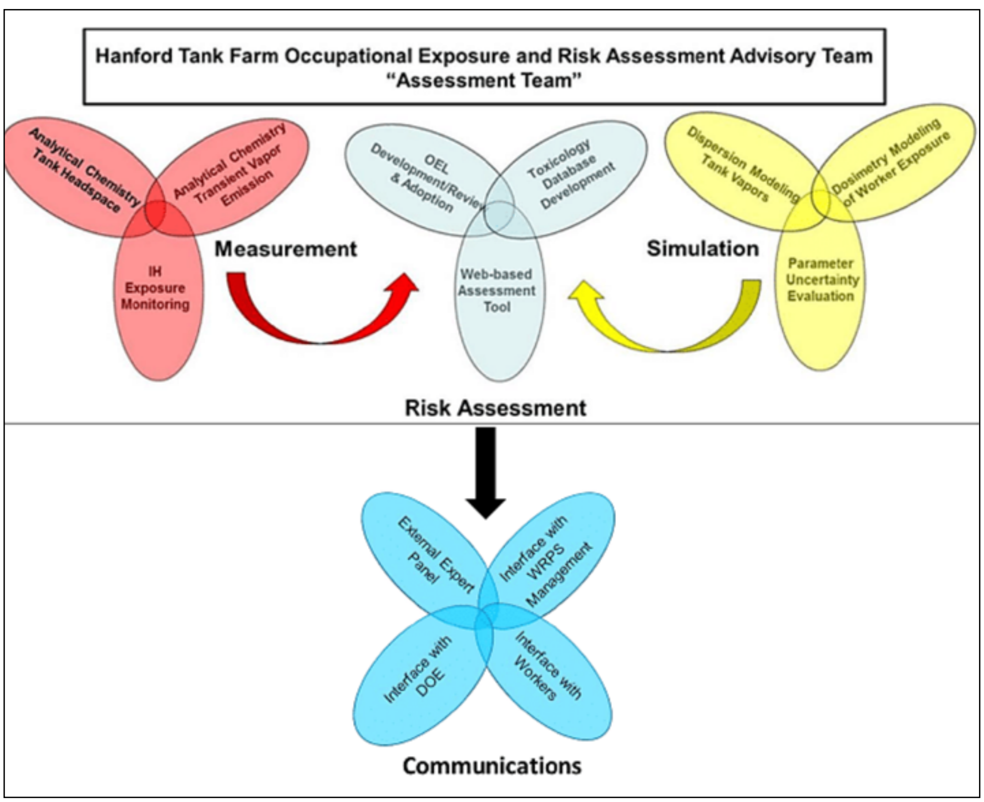
- Conducted successful proof-of-concept tests in May
- Conducted successful offsite engineering-scale tests
- Completed 90% design of NUCON TOS at tank BY-108.

NUCON Thermal Oxidation System

Health Process Plan (HPP) (MTW-24)

Health Process Plan is a peer-reviewed process for assessing potential health risks associated with worker exposures to chemical emissions from the Hanford tank farms. When fully implemented, the recommendations from the plan will facilitate future risk-management decisions that are grounded in state-of-art measurement, simulation and assessment practices. These decisions will enhance the overall work environment and Hanford mission. Technology development accomplishments include:

- Established a process to consider updates to occupational exposure limits that includes internal and external peer review.
- Reviewed current toxicological information and updated the basis for Hanford occupational exposure limits (OELs).
- An Assessment Team has been established for the integration of all information about tank farm emissions, exposure guidelines, and critical data that enable risk-management decisions and stakeholder communications.



HPP Health Risk Assessment Process

Vapors Mobile Lab (MTW-24)

The mobile laboratory van, operated by TerraGraphics, is an analytical laboratory that provides air and vapor analysis around tank farm perimeters. The mobile laboratory monitoring augments Industrial Hygiene sampling and monitoring in the tank farms and monitors outside of the farms for vapor sources.

Vapors Mobile Lab

The mobile laboratory support a variety of projects including:

- Background and leading indicator studies
- FE
- Waste-disturbing activities
- General area sampling
- Real-time quantitative analysis by mass.

Impact include:

- Locates and characterizes the sources of known and fugitive vapor emissions across the Hanford Site
- Provides ultra trace gas analysis for compounds of concern
- Provides data to help minimize operational delays
- Enhances work environment and Hanford mission.

Tank Farm Boundary

Tank Farm Waste-Disturbing Activities

Deep Sludge Gas Removal Event (DSGRE) Investigation (Prior to TEDS Process)

In 2014, C Tank Farm single-shell tank (SST) retrievals operations were on track to remove SST sludge waste and transfer/consolidated in DSTs to a depth greater than previously experienced at Hanford. Previous operational understanding indicated that flammable gases generated in the sludge would escape through a connected pathway of cracks in the sludge. However, some theoretical studies indicated that there was a limit to the depth of the connected pathways, that could result in the gas removal event capturing pockets of gas.

The objective of the DSGRE investigation was to evaluate this theory and resolve the Unreviewed Safety Question (USQ). The test column was fabricated and tested under representative sludge conditions and multiple test scenarios. The results indicated that flammable gases did escape through inherent pathways in the sludge and that the tank farms operations were within the existing safety basis. The test results provided the basis for continuation of tank farm transfers and allowed the furthering of tank closure supporting the Hanford cleanup mission.

Deep Sludge Test Column

Technology development accomplishments include:

- Provided technical basis to enable completion of sludge retrievals from C Tank Farm SSTs
- Completed design and construction of the tall column test system and completed testing to demonstrate the gas retention does not increase with increased waste sludge depth
- Evaluated a theory in the literature of a depth where gas channels collapse, block gas transport, and cause gas instability relative to Hanford specific conditions.

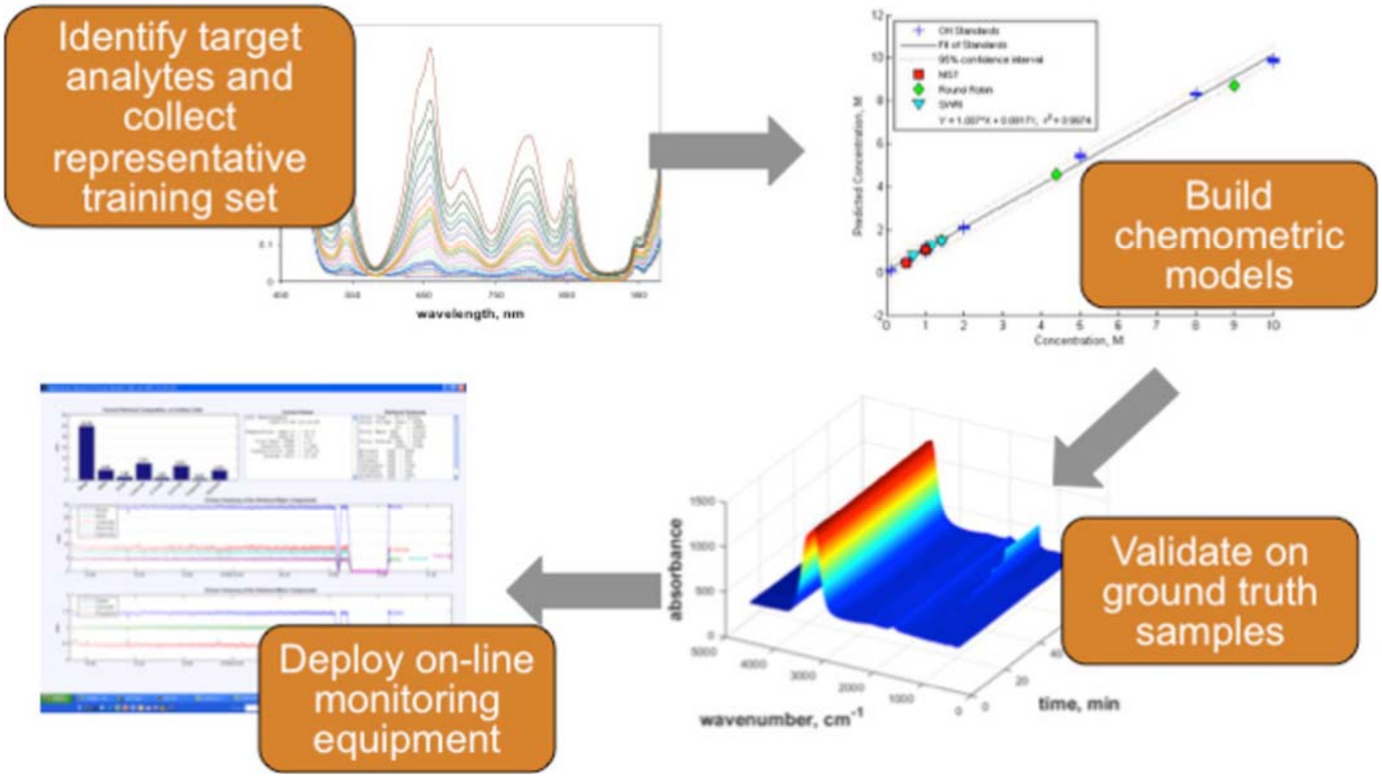
Online Monitoring (Raman Spectroscopy) (MTW-76)

A well-established, commercial technology that has been developed to support an online sampling system to continuously measure tank waste constituents on a per batch basis. Raman spectroscopy is an optical technique used to identify Raman active molecules in a sample. The process starts with laser excitation. The resulting scattered light is then measured, and the light measurements are formed into a spectrum. Technology development is complete and ready for deployment.

Technology development accomplishments include:

- Shorten sample analysis turnaround time
- Increase frequency of sampling
- Decrease costs
- Maintain as low as reasonably achievable (ALARA) exposure
- Allow for more analysis of non-homogenous waste
- Reduction in the need for human interaction with waste samples.

Online Monitoring (Raman Spectroscopy) — Continued



Online Monitoring (Raman Spectroscopy) Development & Deployment Process

Isolok Sampler (Prior to TEDS Process)

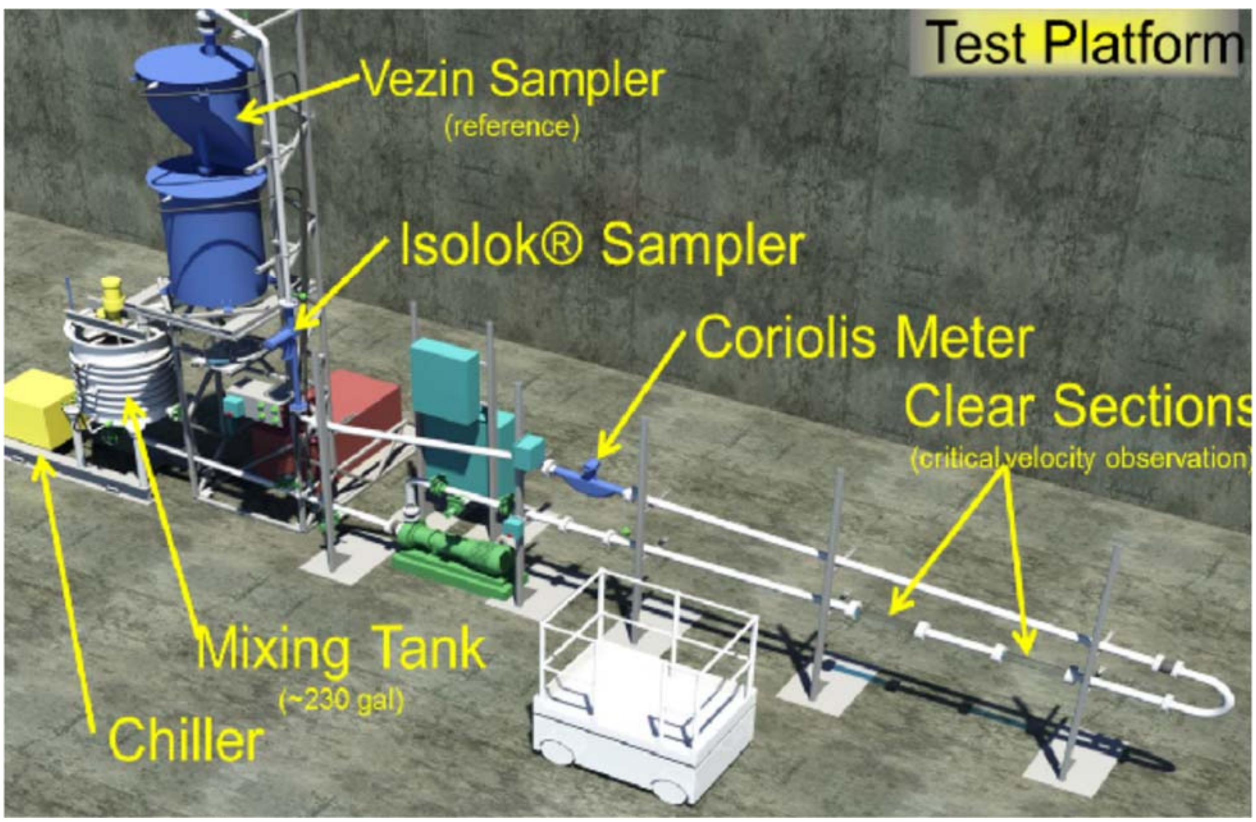
The Isolok sampler is a proposed system that would provide high-level waste (HLW) acceptance samples to the WTP. The Isolok sampler uses a pipe-mounted plunger mechanism that enters the waste stream and collects many small aliquots over time to maintain representativeness. An online ultrasonic pulse echo (UPE) was integrated into the sample loop to allow for measurements of critical velocity.

The benefits of this technology is twofold:

- Allows for tank-side collection of online representative ≤1 liter HLW samples. The samples are evaluated for compliance with waste acceptance criteria and waste feed pre-qualification based on laboratory analysis.
- Prevents transfer line plugging by providing real-time slurry critical velocity measurements.

Technology development accomplishments include:

- Completed the design and fabrication of the Isolok sampler based on a previously proven WTP sampler design (ASX).
- Utilized a reference sampler based on world class expertise to validate and optimize representatives.



Isolock Sample Test Platform Layout

Tank Annulus Floor Cleaning (MTW-82)

In 2002, the primary tank walls of tank AY-101 were cleaned to remove excess corrosion product and debris accumulation. Through the process of cleaning the tank walls, the annulus floor was covered in the corrosion product and debris which caused problems for annulus floor ultrasonic inspection and annulus level monitoring.

This technology enables cleaning the tank walls and the annulus floor, covered in the corrosion product and debris. This enables ultrasonic inspection of the annulus floor, and annulus level monitoring. In FY 2019 after successful factory testing, Rolls-Royce engineers demonstrated the robotic cleaning system before Washington River Protection Solutions, LLC (WRPS) and DOE engineers in Richland. WRPS operators were also trained on the system.

Accomplishments of this technology development are:

- Provided a system that mechanically moves debris and/or remove it from the tank annulus space via containers
- Design, fabrication, and factory acceptance testing completed
- Provided more annulus floor area for visual and nondestructive examination
- Prevent impact to Enraf calibration within the tank AY-101 annulus.

Tank AY-101 Annulus Floor Showing Debris

Annulus Floor Cleaner Mockup

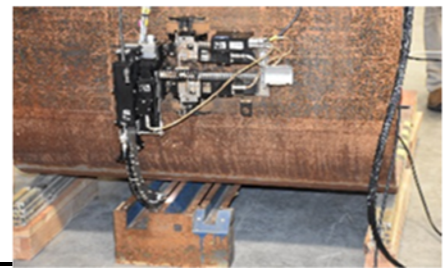
Visual Inspection of DST Primary Tank Bottoms (MTW-15)

The primary liner bottom is currently a part of the tank that cannot be inspected. Visual inspection through the refractory air slots would provide an opportunity to inspect the primary tank bottom. The systems that were developed have given Tank and Pipeline Integrity (TAPI) the ability to access and visually inspect the primary tank bottom through the refractory air slot pattern underneath the DSTs for the first time since the tanks were put into commission.

Accomplishments of this technology development are:

- Provide access to the refractory slots underneath the DST primary shell.
- Reduce the need to build new tanks at a cost of $200 million per tank.
- DST life extension. This technology may help serve to keep existing DSTs in safe operating conditions as long as possible.

Primary Tank Bottom Inspection Crawler



Crawler to Delivery Camera Systems within Refractory Air Slots

Residual Volume Measuring System (RVMS) (RTW-02)

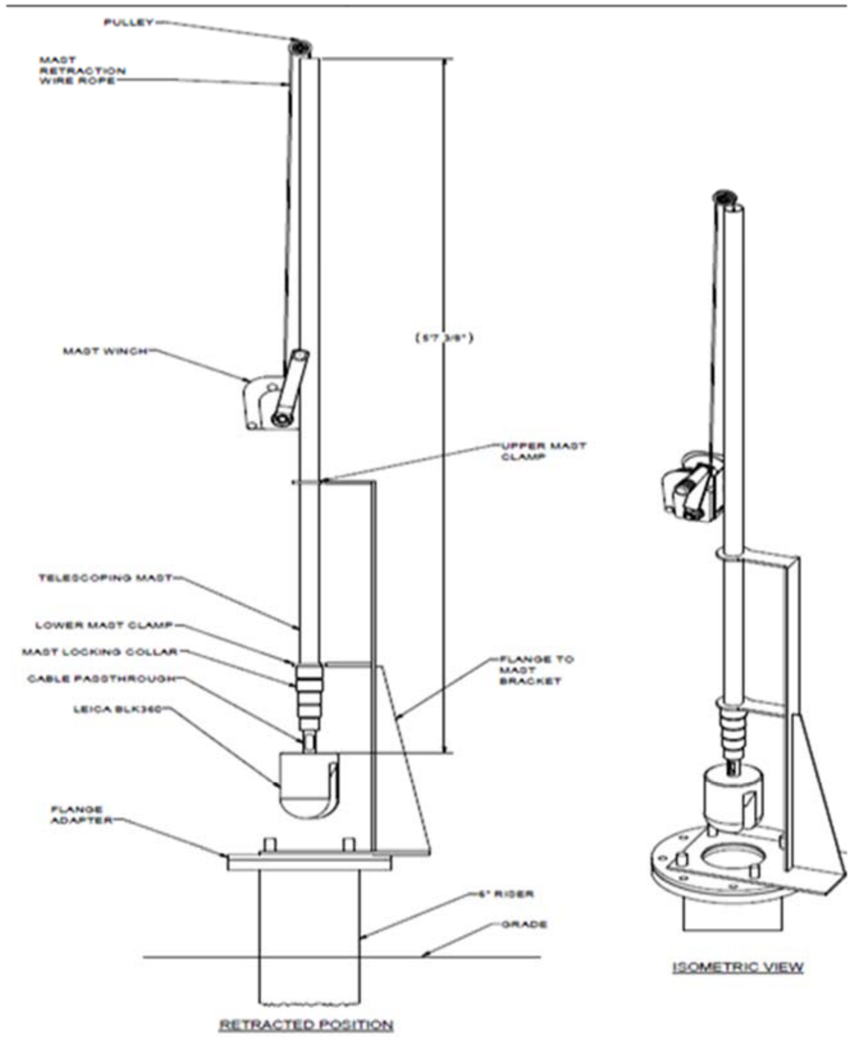
Technology development has been completed. This is a continuous improvement activity. Field deployment is being evaluated. A system evaluation will be conducted for deployment in four risers. Accessibility to 12-in. risers is limited. A smaller system is being tested to access the 4-in. risers that are more accessible. In addition, the integrity and shape of the tank walls and floors is important for tank waste retrieval and closure. More than one access port is being evaluated to attain an accurate tank scan due to obstructions.

RTW-11 Portable Gamma Radiation Monitoring System (RTW-11)

Gamma logging of ex-tank drywells is one method used for leak detection during SST retrievals. A hand-held gamma system was developed and has been successfully deployed it is known as the retrieval drywell monitoring system (RDMS). The RDMS uses bar codes and a barcode reader for telemetry rather than a computer controlled winch. This simpler telemetry system was key to making the system small enough for operators to transport gamma scan equipment into the farm without a vehicle. Modern handheld gamma scanner and probes are part of the new system. Hand-held moisture logging drywells is a currently used for leak detection screening. If changes in the moisture is detected, gamma scans are used to investigate the change. The RDMS will eliminate the need to screen for changes in moisture-reducing farm entries and will gather more definitive leak detection data.

Mobile Gamma Scanner

RVMS Prototype Laser Scanner



Laser Scanner Riser Installation

C3.0 Completed Technology Developments

The Roadmap is a living document. It is updated on an annual basis or as conditions warrant. As expected, during the performance of technology development, some technologies will be successfully completed, overcome by events, deemed unsuccessful, etc. During FY 2020, three technology developments were successfully completed and one deemed unsuccessful. Table C-1 identifies the retired TEDS.

Table C-1. Retired TEDS Sheets.

TEDS	Title	Basis for Retirement
MTW-15	Visual Inspection of DST Primary Tank Bottoms	Successful – development complete
MTW-69	Personal Ammonia Monitor	Deemed unsuccessful and no longer pursued
MTW-82	Tank Annulus Floor Cleaning	Successful – development complete
RTW-11	Portable Gamma Radiation Monitoring System	Successful – development complete
RTW-24	Tank Farm Soil Sampling Technologies	Combined with RTW-01
PTW-52	DFLAW Pretreatment Operations Technology Maturation	Successful – development complete for design, fabrication, and testing
MW-08	ETF Organic Destruction Unit Operation	Successful – development complete
MW-09	Replace ETF Peroxide Destruction Unit Operation	No longer needed
DTW-01	Solidification & Stabilization of LSW from the ETF	Combined with MW-02.
DTW-09	LAW Glass Solutions for Mission-Critical Challenges	Combined with PTW-23
MTW-66	Treatment of NDMA at the Source	Combined with MTW-24
MTW-12	Improve Annulus Air Monitoring	No longer deemed necessary
PTW-41	Methods to Safely Remove, Store and Dispose of Cesium	Work completed through development of TSCR

APPENDIX D

NATIONAL LABORATORY TECHNOLOGY CAPABILITIES MATRIX

D1.0 National Laboratory Technology Capabilities

To help ensure a successful direct-feed low-activity waste (DFLAW) program, the U.S. Department of Energy (DOE), Office of River Protection (ORP) solicited support from the National Laboratories. Their task was to provide a recommended plan identifying capabilities, facilities, and resources. One goal was to minimize duplication of facilities, capabilities, and technical expertise. A second goal was to ensure ORP had sufficient support resources available in a timely manner that minimizes risk and operational down-time for resolution of technical issues occurring during operational phases. The result was an integrated task list describing the work type anticipated during start-up, commissioning, and operations, both initial and steady-state.

The capabilities identified by the National Laboratories consist of eight Core Competencies. These are functional activities the National Laboratories deemed necessary to allow DFLAW operations to successfully complete commissioning, startup, and operation. These eight Core Competencies are:

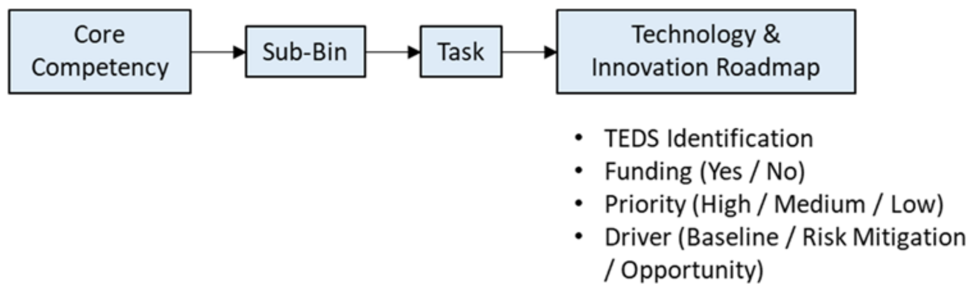
1. Material Integrity & Failure Analysis
2. Waste Forms
3. Analytical Laboratory
4. Process Engineering Support
5. Environmental Sampling & Monitoring
6. Safety Analysis / Safety Basis Support
7. Remote Equipment Engineering
8. Independent Review Team.

These categories are made up of one or more things having some common characteristics or purpose. Each Core Competency was further subdivided or decomposed into lower tier categories known as "sub-bins." These are subordinate groups that share a common differentiated quality. For example, waste forms can be cementitious addressing immobilization of solid or liquid wastes, tank closure, waste disposal, or glass.

For each sub-bin, work tasks were identified. Tasks define a piece of work to be completed and finished within a certain time frame. Tasks were identified from lessons learned of previous operations across the DOE Complex, including the Defense Waste Processing Facility, Saltstone Operations, and Salt Waste Processing Facility at the Savannah River Site. The Core Competencies, sub-bins, and tasks were assembled and documented in a matrix.

Washington River Protection Solutions, LLC (WRPS) reviewed the National Laboratories Capabilities Matrix and developed a crosswalk of existing technology development activities detailed on Technology Element Description Summary (TEDS) sheets. This crosswalk identifies and links technology development activities that support to the National Laboratories Core Competencies. Existing TEDS sheets were evaluated and documented if the matrix items were adequately addressed. In cases where the technology development requirement coverage needed to be expanded, either new TEDS sheets were identified or modifications to existing TEDS sheets were suggested. Funding status, priority, and Baseline/Risk Mitigation/Opportunity drivers are documented for identified TEDS sheets. Figure D-1 depicts the matrix information flow.

Figure D-1. National Laboratory Capability Matrix Decomposition.



An example of this information breakdown for Waste Forms Core Competency is shown in Figure D-2. Waste Forms Core Competency is divided into five sub-bins, each with one or more tasks, linked with Technology & Innovation Roadmap TEDS sheets.

Figure D-2. Core Competency – Waste Forms Example.

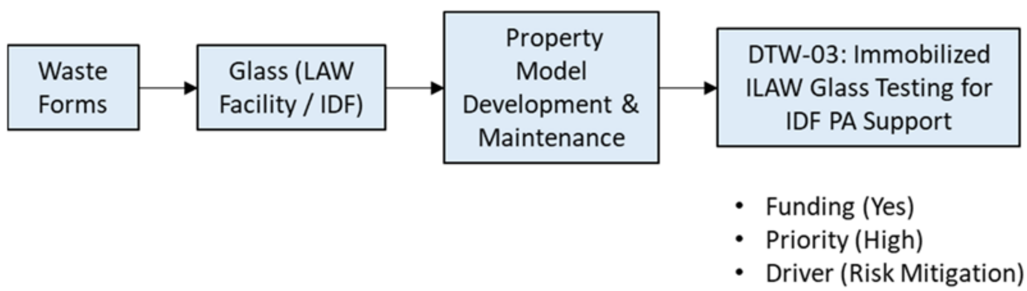


Table D-1 documents the National Laboratories Capabilities Matrix review results. The matrix was incorporated into the Roadmap via addendum RPP-PLAN-62988, *Addendum to the Technology and Information Roadmap Rev. 4*. Updates to the matrix are shown in white text. Retired TEDS sheets have been removed from the matrix.

D2.0 References

RPP-PLAN-62988, 2019, *Addendum to the Technology and Information Roadmap Rev. 4*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

Table D-1. National Laboratory Capability Matrix. (5 sheets)

National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	**Sub-Bin**	**Task**	**TEDS Sheet Identification Number**	**Funded? (Yes / No)**	**Priority (High/Medium/Low)**	**Driver (Baseline/Risk Mitigation/ Opportunity)**
Material Integrity & Failure Analysis	Material Integrity & Failure Analysis	Materials Evaluation	RTW-10: Development Testing of High-Radiation Hose Materials MTW-84: Pipeline Forensic Inspection Technology MTW-85: Remote Profilometry Use for Surface Examination	No No No	Low High High	Risk Mitigation Risk Mitigation Risk Mitigation
		Structural Integrity Assessments	MTW-11: DST Primary Tank Bottom Volumetric Inspection MTW-09: Automated DST Annulus Camera System MTW-73: Tertiary Leak Detection & Foundation Robotic Inspection MTW-10: Phased Array UT Testing Implementation for DST Walls MTW-20: Upgraded Still & Video System for Tank Inspection MTW-78: In-Tank Volumetric Non-Destructive Examination MTW-87: Real-Time Localized Corrosion Monitor-Probe MTW-93: Cesium Online Monitoring for TSCR MTW-10: Phased Array UT Implementation for DST Walls MTW-92: Tank Repair	Yes No Yes No No No Yes Yes No Yes	High Low High Medium High Medium High High Medium High	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Mission Need Risk Mitigation Risk Mitigation
		Failed Component Evaluations	RTW-10: Development Testing of High-Radiation Hose Materials MTW-84: Pipeline Forensic Inspection Technology	No No	Low High	Risk Mitigation Risk Mitigation
Waste Forms	Grout / Cementitious Waste Forms - Liquid Secondary Waste and Supplemental LAW	Liquid Secondary Waste Bench-Scale Formulation & Testing / Facility Equipment & Design	MW-02: Ammonia Vapor Mitigation DTW-02: Low-Temperature Waste Form Process PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps MTW-74: Measure Breathing Rates in Selected SX Tanks DTW-12: Evaluation of Natural Analogues to Support Tailored Grout DTW-13: Long-Term Durability of Cementitious Waste Forms DTW-14: Complex-Wide Database for Cementitious Waste Form Properties	Yes Yes Yes No No No No	High Medium High High Medium Medium Medium	Risk Mitigation Opportunity Risk Mitigation Opportunity Opportunity Opportunity Opportunity
	Grout / Microencapsulation - Solid Secondary Waste	Solid Secondary Waste Bench-Scale Formulation & Testing / Facility Equipment & Design	DTW-07: Solidification and Stabilization of Solid Secondary Waste DTW-08: IDF Long-Term Lysimeter Data Study DTW-13: Long-Term Durability of Cementitious Waste Forms DTW-14: Complex-Wide Database for Cementitious Waste Form Properties	Yes Yes No No	High High Medium Medium	Risk Mitigation Risk Mitigation Opportunity Opportunity
	Closure	Closure	RTW-56: Technology to Support Risk-Based Retrieval and Closure RTW-25: Highly Flowable Grout RTW-01: Retrieval and Closure Solid Waste Sampling Tools RTW-54: Tank Waste Modular Treatment Study RTW-07: Post Waste Retrieval Updates to WMA C PA Maintenance DTW-13: Long-Term Durability of Cementitious Waste Forms DTW-14: Complex-Wide Database for Cementitious Waste Form Properties	No No Yes No No No No	High High High High Medium Medium Medium	Risk Mitigation Risk Mitigation Risk Mitigation Opportunity Risk Mitigation Opportunity Opportunity

Table D-1. National Laboratory Capability Matrix. (5 sheets)

National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	**Sub-Bin**	**Task**	**TEDS Sheet Identification Number**	**Funded? (Yes / No)**	**Priority (High/Medium/Low)**	**Driver (Baseline/Risk Mitigation/ Opportunity)**
	Glass (LAW Facility / IDF)	Formulation and Testing	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-03: Immobilized ILAW Glass Testing for IDF PA Support	Yes Yes	Medium High	Risk Mit. / Opportunity Risk Mitigation
		Property Model Development & Maintenance	DTW-03: ILAW Glass Testing for IDF PA Support	Yes	High	Risk Mitigation
		Implementation of Glass Program	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps	Yes	Medium	Opportunity
	Performance - IDF	Scenario Inputs to PA Baseline (IDF PA Inputs & Modeling)	RTW-07: Post Waste Retrieval Updates to WMA C PA Maintenance RTW-39: Risk Informed Tank Retrieval Modeling Optimization PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-02: Low Temperature Waste Form Process DTW-03: ILAW Glass Testing for IDF PA Support DTW-08: IDF Long-Term Lysimeter Data Study DTW-13: Long-Term Durability of Cementitious Waste Forms	No No Yes Yes Yes Yes No	Medium High Medium Medium High High Medium	Risk Mitigation Risk Mitigation Risk Mit. / Opportunity Opportunity Risk Mitigation Risk Mitigation Opportunity
		Alternative PA Methodology	RTW-07: Post Waste Retrieval Updates to WMA C PA Maintenance RTW-39: Risk Informed Tank Retrieval Modeling Optimization PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-02: Low Temperature Waste Form Process DTW-03: ILAW Glass Testing for IDF PA Support DTW-08: IDF Long-Term Lysimeter Data Study	No No Yes Yes Yes Yes	Medium High Medium Medium High High	Risk Mitigation Risk Mitigation Risk Mit. / Opportunity Opportunity Risk Mitigation Risk Mitigation
		Testing for IDF PA Inputs	DTW-07: Solidification and Stabilization of Solid Secondary Waste DTW-02: Low Temperature Waste Form Process PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-08: IDF Long-Term Lysimeter Data Study	Yes Yes Yes Yes	High Medium Medium High	Risk Mitigation Opportunity Risk Mit. / Opportunity Baseline
Analytical Laboratory	Sample Characterization	LAW Feed Qualification	MTW-37: Tank Waste Characterization & Identification	No	High	Risk Mitigation
		Rad Characterization	MTW-37: Tank Waste Characterization & Identification RTW-57: Plutonium/Absorber Mass Ratios Measurement	No No	High Medium	Risk Mitigation Risk Mitigation
		Statistical Evaluation of Instruments	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Standards Development	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Procedures/Method Development/Training/Troubleshooting	MTW-41: Analytical Method Development for Compounds of Concern MTW-37: Tank Waste Characterization & Identification	No No	High High	Baseline Risk Mitigation
	Real-Time / In-Line Monitoring	Real-Time / In-Line Monitoring	MTW-76: Online Monitoring Using Raman Spectroscopy RTW-31: In-Tank Sampling Technologies for Plutonium Particles MTW-87: Real-Time Localized Corrosion Monitor-Probe MTW-93: Cesium Online Monitoring for TSCR	No No Yes Yes	High Low High High	Opportunity Opportunity Risk Mitigation Mission Need

Table D-1. National Laboratory Capability Matrix. (5 sheets)

National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	Sub-Bin	Task	TEDS Sheet Identification Number	Funded? (Yes / No)	Priority (High/Medium/Low)	Driver (Baseline/Risk Mitigation/ Opportunity)
Process Engineering Support	Overall Flowsheet	Campaign / System Plan Management / Support	PTW-24: Advanced Dynamic Simulation Modeling Platform PTW-42: High-Level Waste Direct Vitrification -- Condensate Treatment RTW-39: Risk Informed Tank Retrieval Modeling Optimization RTW-16: Develop an Integrated HLW Feed Qualification Plan	No No No No	High Medium High Low	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation
		Secondary Waste Composition Estimation	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-07: Solidification and Stabilization of Solid Secondary Waste MW-02: Ammonia Vapor Mitigation	Yes Yes Yes	Medium High High	Risk Mit./Opportunity Risk Mitigation Risk Mitigation
		Key Analyte Tracking and Partitioning	MTW-57: Predicting Behavior of Mercury in EMF RTW-27: Improved Solubility Modeling of Aluminum RTW-28: Improved Solubility Modeling of Oxalate, Fluoride and Other Simple Mixtures RTW-29: Improved Solubility Modeling of Phosphate RTW-32: Neutron Poisons for Criticality Safety of Particulate Plutonium PTW-45: Operations Productivity & Analysis Tools PTW-38: Radioactive Waste Test Platform	No No No No No No Yes	High Medium Medium Medium Medium Medium High	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation N/A Risk Mitigation
		Radioactive Test Platform	PTW-38: Radioactive Waste Test Platform	Yes	High	Risk Mitigation
		Simulant Development / Optimization	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-07: Solidification and Stabilization of Solid Secondary Waste DTW-02: Low Temperature Waste Form Process RTW-16: Develop Integrated HLW Feed Qualification Plan MW-02: Ammonia Vapor Mitigation	Yes Yes Yes No Yes	Medium High Medium Low High	Risk Mit./Opportunity Risk Mitigation Opportunity Risk Mitigation Risk Mitigation
	Unit Operations	Tank Farm Retrieval / Equipment Testing / Mechanical Support	MTW-75: Super-Hydrophobic Metal Surface to Reduce Equipment Contamination MTW-50: Retrieval Support System RTW-01: Retrieval and Closure Solid Waste Sampling Tools RTW-15: Evaluate Back-Up Options for HLW Delivery from Tank Farms RTW-17: Access Deep Sludge Pump Reliability for DST Mixer & Transfer Pumps RTW-12: Development of New Riser Installation System RTW-34: Extended Reach Sluicing System Modifications RTW-08: Dry Sludge Retrieval System RTW-55: Hanford Waste End Effector (Deployment Options) RTW-18: Improved Heat Removal for AW & AN Tanks TSR Heat Limits RTW-33: Instrumentation for Detecting Plutonium Accumulations in Tanks PTW-50: High-Level Waste Solids Segregation MTW-98: Long-Reach Robotic Tools for Tank Farm Pits	No No Yes No No Yes No Yes No No No No No	High Medium High Low Low Medium Medium High High Low Low Medium High	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Opportunity
		Filtration	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps	Yes	Medium	Risk Mit. / Opportunity
		Ion Exchange	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps PTW-48: Prevention of Hydrogen Gas Buildup PTW-49: Feasibility of Removing Nitrates from the LAW Feed MW-15: At-Tank Technetium and Iodine Removal and Disposition	Yes No No No	Medium Medium High High	Risk Mit. / Opportunity Risk Mitigation Opportunity Risk Mitigation
		Vessel Mixing Evaluation and Sampling	RTW-16: Develop Integrated HLW Feed Qualification Plan	No	Low	Risk Mitigation
		Slurry Transport	MTW-36: Slurry Property Investigation	No	Medium	Opportunity

Table D-1. National Laboratory Capability Matrix. (5 sheets)

National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	**Sub-Bin**	**Task**	**TEDS Sheet Identification Number**	**Funded? (Yes / No)**	**Priority (High/Medium/Low)**	**Driver (Baseline/Risk Mitigation/ Opportunity)**
		Glass Former Feed System	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Melter Design Changes & Improvements Testing / Melter Operational Support	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Container Handling / Decontamination Systems	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Melter Offgas System	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps MW-02: Ammonia Vapor Mitigation	Yes Yes	Medium High	Risk Mit. / Opportunity Risk Mitigation
		Melter Condensate System	MW-02: Ammonia Vapor Mitigation	Yes	High	Risk Mitigation
		Evaporation	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps MTW-90: Water/Waste Volume Measurement for 242-A C-A-1 Vessel MTW-91: Tank-Side Waste Evaporation	Yes No No	Medium High Low	Risk Mit. / Opportunity Risk Mitigation Risk Mitigation
		Air Systems	PTW-53: DFLAW Process Operational Troubleshooting (New)	Yes	High	Risk Mitigation
	Unit Operations Troubleshooting	Statistical Process Evaluations	PTW-53: DFLAW Process Operational Troubleshooting (New)	Yes	High	Risk Mitigation
		CFD, Line Plugging, and Transfer	RTW-23: Waste Transfer Pipe Unplugging	No	Low	Risk Mitigation
		LAW Pretreatment System	PTW-54: Real-Time Process Control for DFLAW	Yes	High	Opportunity
		Rheological Properties / Mixing Issues	PTW-23: Methods for Mitigating DFLAW Flowsheet Gaps DTW-07: Solidification & Stabilization of Solid Secondary Waste DTW-02: Low Temperature Waste Form Process MW-02: Ammonia Vapor Mitigation	Yes Yes Yes Yes	Medium High Medium High	Risk Mit. / Opportunity Risk Mitigation Opportunity Risk Mitigation
		Scaling Fouling	MTW-89: Remote Concrete Surface Cleaning Apparatus	No	Low	Opportunity
		Foam Control	PTW-53: DFLAW Process Operational Troubleshooting (NEW)	No	High	Risk Mitigation
		Production Rate	RTW-43: Computer Simulator to Measure Retrieval Operator Skills RTW-21: Improve ESP – A Thermodynamic Modeling Program PTW-26: High- to Mid-Fidelity Consolidated Operators Training Simulator PTW-28: Operations Productivity and Analysis Tools PTW-55: Chemical Process Modeling Software to Support DFLAW Operations MTW-97: Continued Need for Improving Tools for Tank Farm Projects MTW-99: Tank Farm Smart Operating Procedures	No No No Yes Yes No No	Medium Low Medium Medium High Medium Medium	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mit. / Mission Need Opportunity Opportunity
		Special Sample Support	MTW-74: Breathing Rates in Selected SX Tanks	No	High	Risk Mitigation

Table D-1. National Laboratory Capability Matrix. (5 sheets)

National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	**Sub-Bin**	**Task**	**TEDS Sheet Identification Number**	**Funded? (Yes / No)**	**Priority (High/Medium/Low)**	**Driver (Baseline/Risk Mitigation/ Opportunity)**
Environmental Sampling & Monitoring	Environmental Sampling & Monitoring	Vapors / Toxicology	MTW-24: Vapor Monitoring, Characterizing & Remediation MTW-68: Mobile Proton Transfer Reaction - Mass Spectrometer MTW-40: Improve Sampling Methods of Head Space MTW-59: High Silica (Zeolite)-Containing PPE MTW-94: Internal Data Access & Visualization (IDAV) MTW-95: Data Fusion and Advisory System (DFAS)	No No No No Yes Yes	High Medium Low Low Medium High	Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Opportunity Opportunity
		Tank Waste Inventory Monitoring	MTW-13: Improve Liquid Observation Well Data Acquisition MTW-71: Improve Best-Basis Inventory with TWINS Database RTW-44: Use of Sonar & Ultrasound to Quantify Solids in DSTs RTW-57: Plutonium/Absorber Mass Ratios Measurement	No No No No	High Medium Medium Medium	Opportunity Opportunity Opportunity Risk Mitigation
		Corrosion Control	MTW-77: Large-Volume Supernatant Sampler & Transportation System MTW-09: Automated DST Annulus Camera System MTW-11: DST Primary Tank Bottom Volumetric Inspection MTW-73: Tertiary Leak Detection and Foundation Robotic Inspection MTW-10: Electromagnetic Acoustic Transducer and Phased Array MW-10: Remotely Operated or Automated ETF Internal Tank Cleaning Device MTW-86: Protective Measures for Waste Transfer System Lines MTW-83: Secondary Liner Bottom Damage Mitigation Technologies MTW-87: Real-Time Localized Corrosion Monitor-Probe	Yes No Yes Yes No No No Yes Yes	Medium Low High High Medium Medium Low High High	Opportunity Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation Risk Mitigation
		Stack Monitoring	MTW-24: Vapor Monitoring, Characterizing & Remediation MTW-77: Large-Volume Supernatant Sampler & Transportation System	No No	High Medium	Risk Mitigation Risk Mitigation
Safety Analysis / Safety Basis Support	Safety Analysis / Safety Basis Support	Safety Analysis / Safety Basis Support	MTW-70: Plutonium Particulate Criticality Safety Issue Resolution	No	High	Baseline
Remote Equipment Engineering	Remote Equipment Engineering	Sampling System Design	MTW-77: Large-Volume Supernatant Sampler & Transportation System MTW-88: Liquid Air Interface Sampler	Yes No	Medium Medium	Opportunity Risk Mitigation
		Transportation, Packaging and Material Handling	MTW-77: Large-Volume Supernatant Sampler & Transportation System	Yes	Medium	Opportunity
		LAW Container Loading / Transport / Unloading at IDF	DTW-06: Advance Offsite Transportation Capability	No	High	Risk Mitigation
		Secondary Waste Handling Systems	MTW-09: Automated DST Annulus Camera System MTW-10: Phased Array UT Testing Implementation for DST Walls	No No	Low Medium	Risk Mitigation Risk Mitigation

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National Labs Support Plan for DFLAW Startup, Commissioning, and Operation			Technology & Innovation Roadmap			
Core Competency	Sub-Bin	Task	TEDS Sheet Identification Number	Funded? (Yes / No)	Priority (High/Medium/Low)	Driver (Baseline/Risk Mitigation/ Opportunity)
		Specialized Tool Design &Remote Equipment Modifications	MTW-79: Autonomous Robotic Platform	No	Medium	Risk Mitigation
			MTW-81: Radiation-Tolerant Multi-Use Manipulator System	No	High	Risk Mitigation
			MTW-72: Self-Diagnosing Continuous Air Monitoring	No	Medium	Opportunity
			MTW-80: Automated Visual Recognition Wireless Remote Video Monitoring	No	Medium	Opportunity
			RTW-08: Dry Sludge Retrieval System	Yes	High	Risk Mitigation
			RTW-34: Extended Reach Sluicing System Modifications	No	Medium	Risk Mitigation
			RTW-55: Hanford Waste End Effector (Deployment Options)	No	High	Risk Mitigation
			RTW-03: Remote Tank Farm Above Ground Inspections	No	Medium	Risk Mitigation
			RTW-12: Development of New Riser Installation System	Yes	Medium	Risk Mitigation
			MTW-83: Secondary Liner Bottom Damage Mitigation Technologies	Yes	High	Risk Mitigation
			MTW-84: Pipeline Forensic Inspection Technology	No	High	Risk Mitigation
			MTW-85: Remote Profilometry Use for Surface Examination	No	High	Risk Mitigation
			MTW-89: Remote Concrete Surface Cleaning Apparatus	No	Low	Risk Mitigation
			MTW-98: Long-Reach Robotic Tools for Tank Farm Pits	No	High	Opportunity
			MTW-100: Increased NDE Volumetric Inspection	No	Medium	Risk Mitigation
Independent Review Team	Independent Review Team	Readiness Assessment Reviews	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation
		Test Plans for Start-Up / Commissioning	PTW-53: DFLAW Process Operational Troubleshooting (New)	No	High	Risk Mitigation

CFD = computational fluid dynamics.
DFAS = Data Fusion and Advisory System.
DFLAW = direct-feed low-activity waste.
DST = double-shell tank.
DTW = dispose tank waste.
EMF = Effluent Management Facility.
ESP = Electrical Safety Program.
ETF = Effluent Treatment Facility.
HLW = high-level waste.
IDAV = internal data access and visualization.
IDF = Integrated Disposal Facility.
ILAW = immobilized low-activity waste.
LAW = low-activity waste.
LSW = liquid secondary waste.
MTW = manage tank waste.
MW = manage waste.
N/A = not applicable.
PA = performance assessment.
PPE = personal protective equipment.
PTW = process tank waste.
RTW = retrieve tank waste.
TEDS = Technical Element Description Summary.
TSCR = tank-side cesium removal.
TSR = Technical Safety Requirement.
TWINS = Tank Waste Information Network System.
WMA = waste management area.
WTP = Waste Treatment and Immobilization Plant.

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