## DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

TRADEMARK DISCLAIMER: Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof or its contractors or subcontractors. Printed in the United States of America.

### 1. Doc No: RPP-PLAN-43988  Rev. 04

### 2. Title:
Technology and Innovation Roadmap

### 3. Project Number: ☒ N/A

### 4. Design Verification Required:
☐ Yes  ☒ No

### 5. USQ Number: ☒ N/A

### 6. PrHA Number Rev. ☒ N/A

### 7. Approvals

<table>
<thead>
<tr>
<th>Title</th>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance Review</td>
<td>Raymer, Julia R</td>
<td>Raymer, Julia R</td>
<td>09/20/2018</td>
</tr>
<tr>
<td>Document Control Approval</td>
<td>Scales, Anthony</td>
<td>Scales, Anthony</td>
<td>09/20/2018</td>
</tr>
<tr>
<td>Originator</td>
<td>Kim, Amie J</td>
<td>Kim, Amie J</td>
<td>08/29/2018</td>
</tr>
<tr>
<td>Other Approver</td>
<td>Reid, Doug J</td>
<td>Reid, Doug J</td>
<td>08/29/2018</td>
</tr>
<tr>
<td>Other Approver</td>
<td>Wooley, Ted</td>
<td>Wooley, Ted</td>
<td>08/29/2018</td>
</tr>
<tr>
<td>Responsible Manager</td>
<td>Boomer, Kayle D</td>
<td>Boomer, Kayle D</td>
<td>08/30/2018</td>
</tr>
</tbody>
</table>

### 8. Description of Change and Justification
Updated to reflect FY18 changes. Streamlined format.

### 9. TBDs or Holds: ☒ N/A

### 10. Related Structures, Systems, and Components

#### a. Related Building/Facilities: ☒ N/A

#### b. Related Systems: ☒ N/A

#### c. Related Equipment ID Nos. (EIN): ☒ N/A

### 11. Impacted Documents – Engineering: ☒ N/A

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Rev.</th>
<th>Title</th>
</tr>
</thead>
</table>

### 12. Impacted Documents (Outside SPF): N/A

### 13. Related Documents: ☒ N/A

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Rev.</th>
<th>Title</th>
</tr>
</thead>
</table>

### 14. Distribution

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm, Stuart</td>
<td>FLOWSHEET INTEGRATION</td>
</tr>
<tr>
<td>Aurah, Mirwaise</td>
<td>PROCESS &amp; CONTROL SYSTEM ENG</td>
</tr>
<tr>
<td>Baider, Kent</td>
<td>MISSION ANALYSIS ENGINEERING</td>
</tr>
<tr>
<td>Baide, Dan</td>
<td>PROCESS ENGINEERING ANALYSIS</td>
</tr>
<tr>
<td>Bang, Ricky</td>
<td>SAFETY AND HEALTH DIVISION</td>
</tr>
<tr>
<td>Baune, Heather</td>
<td>TKN WST INVENTORY &amp; CHARACTZTN</td>
</tr>
<tr>
<td>Boomer, Kayle</td>
<td>TECH MGMT &amp; FIELD SOLUTIONS</td>
</tr>
<tr>
<td>Brown, Elvie</td>
<td>TECHNOLOGY MATURATN &amp; ANALYSIS</td>
</tr>
<tr>
<td>Calmus, Ron</td>
<td>VAPOR TECHNOLOGY SOLUTIONS</td>
</tr>
<tr>
<td>Colosi, Kris</td>
<td>CHIEF TECHNCLGY OFFICE/CLOSURE</td>
</tr>
<tr>
<td>Cooke, Gary</td>
<td>PROCESS CHEMISTRY</td>
</tr>
<tr>
<td>Davis, Neil</td>
<td>ENGINEERING</td>
</tr>
<tr>
<td>Davis, Renee</td>
<td>MISSION INTEGRATION OPERATIONS</td>
</tr>
<tr>
<td>Durfee, Steve</td>
<td>FUNDS AND COST MANAGEMENT</td>
</tr>
<tr>
<td>Fountain, Matthew</td>
<td>FLOWSHEET INTEGRATION</td>
</tr>
<tr>
<td>Frank, Robert</td>
<td>MISSION INTEGRATION &amp; WFD QA</td>
</tr>
<tr>
<td>Garrett, Mark</td>
<td>PRODUCTION OPERATIONS</td>
</tr>
<tr>
<td>Greenwell, Doug</td>
<td>SST RETRIEVAL</td>
</tr>
<tr>
<td>Hamilton, Peggy</td>
<td>A AND AX FARM RETRIEVAL</td>
</tr>
<tr>
<td>Houghton, David</td>
<td>TF PROJECTS &amp; INTEGRITY ENGRNG</td>
</tr>
<tr>
<td>Huber, John</td>
<td>DESIGN ENGINEERING</td>
</tr>
<tr>
<td>Johnson, Jeremy</td>
<td>TF PROGRAMS DIVISION</td>
</tr>
<tr>
<td>Kim, Amie J</td>
<td>TECH MGMT &amp; FIELD SOLUTIONS</td>
</tr>
<tr>
<td>Kirch, Nick</td>
<td>FROD OPERATIONS PROCESS ENGRNG</td>
</tr>
<tr>
<td>Larock, Eric</td>
<td>SST RETRIEVAL</td>
</tr>
<tr>
<td>Lynch, James</td>
<td>TF PROGRAMS DIVISION</td>
</tr>
<tr>
<td>Name</td>
<td>Organization</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Mendoza, Ruben E</td>
<td>TANK &amp; PIPELINE INTEGRITY</td>
</tr>
<tr>
<td>Myer, Thom G</td>
<td>C FARM RETRIEVAL</td>
</tr>
<tr>
<td>Rambo, Jeffrey J</td>
<td>IF PROGRAMS DIVISION</td>
</tr>
<tr>
<td>Reid, Doug J</td>
<td>TECHNOLOGY MATURATN &amp; ANALYSIS</td>
</tr>
<tr>
<td>Reynolds, Jacob G</td>
<td>FLOWSHEET INTEGRATION</td>
</tr>
<tr>
<td>Rutland, Paul L</td>
<td>CLOSURE &amp; INTERIM MEASURES</td>
</tr>
<tr>
<td>Stewart, Dustin M</td>
<td>TF PROGRAMS DIVISION</td>
</tr>
<tr>
<td>Subramanian, Karthik H</td>
<td>MISSION INTEGRATION</td>
</tr>
<tr>
<td>Sutey, Mike</td>
<td>SST R&amp;C PROJECT ENGINEERING</td>
</tr>
<tr>
<td>Swanberg, David J</td>
<td>TECHNOLOGY MATURATN &amp; ANALYSIS</td>
</tr>
<tr>
<td>Vitali, Jason K</td>
<td>CHIEF TECHNOLOGY OFFICE</td>
</tr>
<tr>
<td>Wagner, Vikki</td>
<td>C FARM RETRIEVAL</td>
</tr>
<tr>
<td>Wheeler, Martin</td>
<td>PROGRAM INTEGRATION</td>
</tr>
<tr>
<td>Wooley, Ted</td>
<td>TECH MGMT &amp; FIELD SOLUTIONS</td>
</tr>
</tbody>
</table>
**INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL**

### Part I: Background Information

<table>
<thead>
<tr>
<th>Title: Technology and Innovation Roadmap</th>
<th>Information Category:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ Abstract  □ Journal Article  □ Summary</td>
</tr>
<tr>
<td></td>
<td>□ Internet  □ Visual Aid  □ Software</td>
</tr>
<tr>
<td></td>
<td>□ Full Paper  □ Report  □ Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Publish to OSTI?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Trademark/Copyright “Right to Use” Information or Permission Documentation: Yes NA

<table>
<thead>
<tr>
<th>Document Number: RPP-PLAN-43988 Revision 4</th>
<th>Date: August 2018</th>
</tr>
</thead>
</table>

Author: Kim, Amie J

### Part II: External/Public Presentation Information

<table>
<thead>
<tr>
<th>Conference Name:</th>
<th>Sponsoring Organization(s): DOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference Location:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Will Material be Handed Out?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Will Information be Published?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

(If Yes, attach copy of Conference format instructions/guidance.)

### Part III: WRPS Document Originator Checklist

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
</table>

Information Product meets requirements in TFC-BSM-AD-C-01? Yes

Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist) Yes

If product contains pictures, safety review completed? Yes Roberts, Sheryl K Approved via att. IDMS data file.

### Part IV: WRPS Internal Review

<table>
<thead>
<tr>
<th>Function</th>
<th>Organization</th>
<th>Date</th>
<th>Print Name/Signature/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsible Manager</td>
<td>WRPS</td>
<td>Boomer, Kayle D Approved via att. IDMS data file.</td>
<td></td>
</tr>
</tbody>
</table>

Other:

### Part V: IRM Clearance Services Review

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Document Contains Classified Information? Yes

Document Contains Information Restricted by DOE Operational Security Guidelines? Yes

Document is Subject to Release Restrictions? Yes Document contains:

- □ Applied Technology
- □ Protected CRADA
- □ Personal/Private
- □ Export Controlled
- □ Proprietary
- □ Procurement – Sensitive
- □ Patentable Info.
- □ OUO
- □ Predecisional Info.
- □ UCNI
- □ Restricted by Operational Security Guidelines
- □ Other (Specify)

Additional Comments from Information Clearance Specialist Review? Yes

Information Clearance Specialist Approval

Approved via att. IDMS data file.

Print Name/Signature/Date

When IRM Clearance Review is Complete – Return to WRPS Originator for Final Signature Routing (Part VI)
The Technology and Innovation Roadmap is a planning tool for WRPS management, DOE ORP, DOE EM, and others to understand the risks and technology gaps associated with the RPP mission. The roadmap identifies and prioritizes technical areas that require technology solutions and underscores where timely and appropriate technology development can have the greatest impact to reduce those risks and uncertainties.

**Information Release Station**

Was/Is Information Product Approved for Release?  ✔ Yes  □ No

If Yes, what is the Level of Releaser?  ✔ Public/Unrestricted  □ Other (Specify) 

Date Information Product Stamped/Marked for Release:  9/19/2018

Was/Is Information Product Transferred to OSTI?  □ Yes  ✔ No

Forward Copies of Completed Form to WRPS Originator
- <workflow name="(JRR) RPP-PLAN-43988-04" id="229059778">
- <task name="Clearance Process" id="0" date-initiated="20180830T0908"
  performer="Julia R Raymer" performer-id="164931488" username="h3310581">
  <comments>Please approve RPP-PLAN-43988, Rev. 4, for public release.
  POC: Amie Kim (Feero) (509) 376-2309 Thank you, Julia Raymer (509) 373-0230</comments>
</task>
- <task name="Add XML" id="1" date-done="20180830T0908" />
- <task name="Manager Approval" id="41" date-due="20180904T0908" date-done="20180830T1025"
  performer="Kayle D Boomer" performer-id="1077359" username="h0046193" disposition="Approve"
  authentication="true" />
- <task name="Document Reviewer1" id="54" date-due="20180904T0704" date-done="20180830T1025"
  performer="Sheryl K Roberts" performer-id="171787680" username="h0081997" disposition="Public Release"
  authentication="true" />
- <task name="Document Reviewer2" id="53" date-done="20180904T0717" date-due="20180904T0731"
  performer="Jerry N Holloway" performer-id="140435533" username="h0087835" disposition="Public Release"
  authentication="true" />
- <task name="Document Reviewer3" id="52" date-done="20180904T0731" date-due="20180904T0731"
  performer="Stephen B Cherry" performer-id="1382719" username="h0374767" disposition="Public Release"
  authentication="true" />
- <task name="Doc Owner Clearance Review" id="13" date-done="20180907T0731" date-due="20180907T0731"
  performer="Amie (Feero) J Kim" performer-id="162157556" username="h4210054" disposition="Send On"
  authentication="true" />
- <task name="Milestone 1" id="24" date-done="20180906T0925" />
- <task name="ORP Document Reviewer1" id="57" date-done="20180910T0925" date-due="20180910T0925"
  performer="Richard A Marshall" performer-id="203862915" username="h4535783" disposition="Public Release"
  authentication="true" />
  <reviewer performer="Naomi M Jaschke" performer-id="68788398" username="h6764369" />
  <reviewer performer="Mark D Silberstein" performer-id="158207236" username="h5490246" />
  <reviewer performer="Yvonne M Levardi" performer-id="185346745" username="h7131303" />
  <comments>Reviewer's Comments Date: 09/13/2018 12:43 PM Step Name: RPP-RPT-43988 R4 Technology and Innovation Roadmap Performer: Jaschke, Naomi (h6764369) No comments. Reviewer's Comments Date: 09/13/2018 02:55 PM Step Name: RPP-PLAN-43988 R4 Technology and Innovation Roadmap Performer: Silberstein, Mark (h5490246) approve Reviewer's Comments Date: 09/18/2018 11:44 AM Step Name: RPP-PLAN-43988 R4 Technology and Innovation Roadmap Performer: Levardi, Yvonne (h7131303)</comments>
</task>
<task name="Doc Owner Reviews ORP Comments" id="61" date-due="20180919T1253" date-done="20180919T1253" performer="Amie (Feero) J Kim" performer-id="162157556" username="h4210054" disposition="Send On" authentication="true" />
<task name="Milestone 2" id="62" date-done="20180919T1253" />
<task name="Verify Doc Consistency" id="4" date-due="20180920T1253" date-done="20180919T1336" performer="Julia R Raymer" performer-id="164931488" username="h3310581" disposition="Cleared" authentication="true" />
</workflow>
Technology and Innovation Roadmap

Prepared by

D. J. Reid
T. A. Wooley
A. J. Kim
Washington River Protection Solutions, LLC

Date Published
September 2018

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

Approved for Public Release;
Further Dissemination Unlimited
TECHNOLOGY
and
INNOVATION
ROADMAP

Published: September 2018

D.J. Reid
T.A. Wooley
A.J. Kim
EXECUTIVE SUMMARY

This Technology and Innovation Roadmap presents a comprehensive, integrated assessment of the technology elements related to maintaining the 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 mission needs with respect to the next 10 years are identified and prioritized. This Technology and Innovation Roadmap is used to assist with planning near-term scope to address technology development priorities in fiscal year 2019.

Each year the document is updated with input from several key sources including DOE; Washington River Protection Solutions, LLC management; and 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 sheets. A council of representatives from the Tank Operations Contractor and ORP use the summaries to prioritize the technology elements into low, medium, and high priorities. The high-priority technology elements are ranked with further clarity to yield a priority list. Once the ranking has occurred, catalog sheets are developed for each summary to highlight each technology element, and the document is compiled and released for use within the DOE complex.

Specific areas of focus for technology development, as defined through the priorities provided by ORP for fiscal year 2019, included:

- Tank Waste and Secondary Waste Treatment and Tank Closure
- Comprehensive Vapor Actions
- Work to Support Safe Stabilization and Disposal of Waste
- Tank Integrity Program
- Cross-Site Transfer Line.

These priorities were considered during the ranking process of the compiled Technology Element Description Summary sheets. The resulting high priority technology elements are emphasized as potential solutions to the significant technical challenges facing the tank waste cleanup mission and to enhance the safety of the workforce. The information presented in the Technology and Innovation Roadmap can be used to guide technical and scope priorities for the River Protection Project mission and effect change as necessary.
LIST OF FIGURES

Figure 2-1. Hanford Tank Waste Description................................................................. 2-1
Figure 3-1. Technology Development Process............................................................... 3-1
Figure 3-2. Functional Area Summary............................................................................. 3-2
Figure 5-1. National Laboratory Support ........................................................................ 5-1
Figure 5-2. Technology Development Funding Distribution.............................................. 5-2
Figure 5-3. CTO Managed Technology Development and Maturation Scope................... 5-3

LIST OF TABLES

Table 5-1. Priority Ranking of High-Priority TEDS Sheets.............................................. 5-5
LIST OF TERMS

Acronyms and Abbreviations

2D  two-dimensional
3D  three-dimensional
ALARA  as low as reasonably achievable
ASCEM  Advanced Simulation Capability for Environmental Management
BBI  best-basis inventory
CAM  continuous air monitor
CCN  cloud condensation nuclei
CD  Critical Decision
CH  contact-handled
CHPRC  CH2M HILL Plateau Remediation Company
COC  compound of concern
Cs  cesium
CST  crystalline silicotitanate
CTO  Chief Technology Office
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
EM  U.S. Department of Energy, Office of Environmental Management
EMAT  electromagnetic acoustic transducer
EMF  Effluent Management Facility
ERSS  extended reach sluicing system
ETF  Effluent Treatment Facility
FID  flame ionization detection
FTIR  Fourier transform infrared
FY  fiscal year
GC-FID  gas chromatography flame ionization detection
GC-MS  gas chromatography mass spectrometry
GEIT  General Electric Inspection Technology
GPS  global positioning system
HIHTL  hose-in-hose transfer line
HLW  high-level waste
HWEE  Hanford waste end effector
IDF  Integrated Disposal Facility
IHLW  immobilized high-level waste
ILAW  immobilized low-activity waste
IMUST  inactive miscellaneous underground storage tank
IX  ion exchange
LAW  low-activity waste
LCO  Limiting Condition of Operation
LAWPS  Low-Activity Waste Pretreatment System
LERF  Liquid Effluent Retention Facility
LIDAR  light detection and ranging
LOW  liquid observation well
LTA  less than adequate
MARS-V  vacuum-mode mobile arm retrieval system
MWGS  mechanical waste gathering system
MUST  miscellaneous underground storage tank
MTW  manage tank waste
MW  manage waste
N/A  not applicable
**LIST OF TERMS (Continued)**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDE</td>
<td>nondestructive examination</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>MW</td>
<td>manage waste</td>
</tr>
<tr>
<td>NDMA</td>
<td>n-nitrosodimethylamine</td>
</tr>
<tr>
<td>NOX</td>
<td>nitrous oxide</td>
</tr>
<tr>
<td>OP-FTIR</td>
<td>open path Fourier transform infrared</td>
</tr>
<tr>
<td>ORP</td>
<td>U.S. Department of Energy, Office of River Protection</td>
</tr>
<tr>
<td>ORSS</td>
<td>off-riser sampler system</td>
</tr>
<tr>
<td>OTS</td>
<td>operator training simulator</td>
</tr>
<tr>
<td>PA</td>
<td>performance assessment</td>
</tr>
<tr>
<td>PNNL</td>
<td>Pacific Northwest National Laboratory</td>
</tr>
<tr>
<td>PPE</td>
<td>personal protective equipment</td>
</tr>
<tr>
<td>PTR-MS</td>
<td>proton transfer reaction – mass spectrometer</td>
</tr>
<tr>
<td>PTW</td>
<td>process tank waste</td>
</tr>
<tr>
<td>Pu</td>
<td>plutonium</td>
</tr>
<tr>
<td>Risk Registry</td>
<td>Enterprise Risk and Opportunity Management Program</td>
</tr>
<tr>
<td>Roadmap</td>
<td>Technology and Innovation Roadmap</td>
</tr>
<tr>
<td>RPP</td>
<td>River Protection Project</td>
</tr>
<tr>
<td>RTW</td>
<td>retrieve tank waste</td>
</tr>
<tr>
<td>RVMS</td>
<td>residual volume measuring system</td>
</tr>
<tr>
<td>SBS</td>
<td>submerged bed scrubber</td>
</tr>
<tr>
<td>SLW</td>
<td>secondary liquid waste</td>
</tr>
<tr>
<td>SPP</td>
<td>Strategic Partnership Program</td>
</tr>
<tr>
<td>sRF</td>
<td>spherical resorcinol formaldehyde</td>
</tr>
<tr>
<td>SST</td>
<td>single-shell tank</td>
</tr>
<tr>
<td>SSW</td>
<td>secondary solid waste</td>
</tr>
<tr>
<td>SWITS</td>
<td>Solid Waste Information and Tracking System</td>
</tr>
<tr>
<td>TBD</td>
<td>to be determined</td>
</tr>
<tr>
<td>Tc</td>
<td>technetium</td>
</tr>
<tr>
<td>TEDS</td>
<td>Technology Element Description Summary</td>
</tr>
<tr>
<td>TEM</td>
<td>transmission electron microscopy</td>
</tr>
<tr>
<td>TOC</td>
<td>Tank Operations Contractor</td>
</tr>
<tr>
<td>TRA</td>
<td>Technology Readiness Assessment</td>
</tr>
<tr>
<td>TRL</td>
<td>Technology Readiness Level</td>
</tr>
<tr>
<td>TRU</td>
<td>transuranic</td>
</tr>
<tr>
<td>TSR</td>
<td>Technical Safety Requirement</td>
</tr>
<tr>
<td>TWCS</td>
<td>tank waste characterization and staging</td>
</tr>
<tr>
<td>TWINS</td>
<td>Tank Waste Information Network System</td>
</tr>
<tr>
<td>UT</td>
<td>ultrasonic testing</td>
</tr>
<tr>
<td>UV</td>
<td>ultraviolet</td>
</tr>
<tr>
<td>UV-DOAS</td>
<td>ultraviolet differential optical adsorption spectroscopy</td>
</tr>
<tr>
<td>UV-FTIR</td>
<td>ultraviolet Fourier transform infrared stack monitor</td>
</tr>
<tr>
<td>VMDS</td>
<td>vapor monitoring and detection system</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic chemical</td>
</tr>
<tr>
<td>VWB</td>
<td>virtual workbench</td>
</tr>
<tr>
<td>WAC</td>
<td>waste acceptance criteria</td>
</tr>
<tr>
<td>WBS</td>
<td>work breakdown structure</td>
</tr>
<tr>
<td>WESP</td>
<td>wet electrostatic precipitator</td>
</tr>
<tr>
<td>WFD</td>
<td>waste feed delivery</td>
</tr>
<tr>
<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
</tr>
<tr>
<td>WMA</td>
<td>waste management area</td>
</tr>
<tr>
<td>WRPS</td>
<td>Washington River Protection Solutions, LLC</td>
</tr>
<tr>
<td>WTP</td>
<td>Waste Treatment and Immobilization Plant</td>
</tr>
<tr>
<td>XRD</td>
<td>x-ray diffractometer</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

In early 2007, the U.S Department of Energy (DOE), Office of Environmental Management (EM) prepared a congressionally requested 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 Assistant Secretary for EM of leveraging existing technology, using lessons-learned across the complex, and incorporating “transformational technologies” to improve the mission. The scope for Revision 1 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 was the same; however, the content was updated to incorporate interim progress and changing mission priorities. The scope for Revision 3 was the same as the other revisions; however, Revision 3 improvements included addressing integration of the DOE Office of River Protection (ORP) Grand Challenge technologies and updated technology prioritization and ranking processes based on ORP mission objectives.

This Revision 4 serves to more closely link technologies with risks identified in the 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 identify and prioritize the planned and needed waste remediation technologies in order to inform fiscal budget planning, prevent redundant efforts, prioritize National Laboratory work, and communicate with stakeholders. Because Revision 4 is intended to be a planning document, the conclusions of this report are based on technological priorities for fiscal year (FY) 2019. The Technology Element Description Summary (TEDS) sheets still identify cost from FY 2018, but this is merely for information purposes.

The document is compiled based on input from ORP; Washington River Protection Solutions, LLC (WRPS) management; and knowledgeable subject matter experts. All of the known technology needs are identified by the appropriate subject matter experts and summarized via individual TEDS sheets. A council of representatives from the TOC and ORP use the summaries to prioritize the technology elements into low, medium, and high priorities. The high-priority technology elements are ranked with further clarity to yield a priority list. Once the ranking has occurred, catalog sheets are developed for each summary to highlight each technology need, and the document is compiled and released for use within the DOE complex.
2.0 BACKGROUND

An estimated 54 Mgal\(^3\) of chemical and radioactive waste are stored in 177 underground tanks at the Hanford Site in southeastern Washington State. This waste resulted from plutonium production for the nation’s nuclear defense program and ensuing waste management. There are 149 single-shell tanks (SST), which were constructed between 1943 and 1964. The SSTs contain mostly sludge and salt cake and are currently only used for storage; they have had nearly all of the pumpable liquid removed as part of the Interim Stabilization Program. The 28 double-shell tanks (DST) at the Hanford Site were constructed between 1968 and 1986. The waste tanks contain a complex and diverse mix of radioactive and chemical waste in the form of sludge, saltcake, and supernatant, necessitating a variety of unique waste retrieval, treatment, and disposition methods. Descriptions and volumes of these waste types are provided in Figure 2-1.

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)

\(^3\)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 January 31, 2018, Rev. 361, Washington River Protection Solutions, LLC, Richland, Washington.
In 1989, DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology (Ecology) entered into enforceable compliance agreement *Hanford Federal Facility Agreement and Consent Order–Tri-Party Agreement* (Ecology et al. 1989), hereinafter referred to as the Tri-Party Agreement, setting 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. The RPP mission 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 in the Waste Treatment and Immobilization Plant (WTP)
- 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 first bullet by storing, maintaining, and retrieving tank waste. The future responsibilities of the TOC are to feed tank waste to the WTP in order to accomplish the second bullet and to assume responsibility of the waste forms that are stored on the Hanford Site to accomplish the third bullet.

---

4 This reference includes all applicable amendments of the Tri-Party Agreement.
3.0 PROCESS SUMMARY

The 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. This process is used to ensure that the planning and strategic initiatives agree. These sources include the following: (1) previous year’s Roadmap; (2) those technologies derived from projects’ technology maturation; (3) ORP priority letter 18-WSC-0016, “Contract Number DE-AC27-08RV14800 – Fiscal Year 2018 Preliminary Budget Guidance for Technology Roadmap and Chief Technology Office”; (4) facility needs; (5) stakeholder input; (6) Risk Register; (7) Grand Challenges; and (8) programmatic planning documents. Most of these inputs are Hanford-centered, but the Grand Challenge provides solicitations from industry, academia, and the DOE-wide complex.

Figure 3-1. Technology Development Process.
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 formas. 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 technologies. The TEDS is a standardized tool that enables direct comparison of provided input. The TEDS sheets primarily include the following information:

- Technology summary
- Priority ranking
- Functional area
- Grand Challenge
- Technology impact and risk identification
- Technology need
- Technology solution
- Technology maturation level / National laboratory (yes or no?)
- Cost and schedule
- Points of contact

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. 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.

5 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 (Note: 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 pro formas, and new TEDS sheets were created if necessary.

Another important input into the technology needs was the DOE priority letter of direction (18-WSC-0016). That letter identifies technology development opportunities that could support tank waste immobilization to begin prior to resolution of technical issues associated with the WTP Pretreatment Facility and High-Level Waste (HLW) Facility. Therefore, letter 18-WSC-0016 primarily focuses on implementing technologies related to glass, grout and vapors, which will facilitate the start of tank waste immobilization and provide additional flexibility to the tank waste treatment system. A technology listed in letter 18-WSC-0016 is referred to as a strategic initiative. A TEDS was created for any technology mentioned in that letter that did not previously have a TEDS.

Technology development is partially driven by the need to mitigate risk and realize opportunity; therefore, the risk registers are crucial input into the technology needs. The risks and opportunities are identified, managed, and assessed via the Enterprise Risk and Opportunity Management Program (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 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.

The Grand Challenge Workshop brings together members of DOE, the National Laboratories, academia, contractors, and outside industries. Each year new ideas are presented to DOE, and those ideas that are related to technology development are incorporated into a TEDS sheet. The Grand Challenge Workshop and the Roadmap together encourage a culture of continuous improvement in safety and mission efficiency and engage our internal workforce and the external scientific community in the process of overcoming our biggest challenges.

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, and from 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.

### 3.2 Rating and Ranking Technologies

After all the technology needs are identified in an individual TEDS sheet, the technologies are then prioritized. A council of representatives from the TOC and ORP use the judging criteria to prioritize the technology elements. Initially each technology is assigned a priority of high, medium, or low based primarily on when the technology is needed to address key mission priorities (see Appendix B, Figure B-1).
A high priority is given to technologies determined to be needed within 1 to 4 years. This assignment is usually made by the author of the individual TEDS sheet but then must be validated by the council. Only the high-priority TEDS sheets are moved through the ranking and rating process. Ranking and rating allows all the high-priority TEDS sheets to be further prioritized. In other words, identifying many high-priority technology development activities at once may not coincide with budgetary restrictions.

Prioritization is based upon applying three categories of assessment criteria (Appendix B, Table B-1) 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 scope of priorities for the RPP technology development. Details on the evaluation criteria and priority ranking protocols are included in Appendix B.

### 3.3 Catalog Sheets

The information provided by the TEDS sheets is used to prepare catalog sheets to highlight each technology need. The catalog sheets are a concise summary of technology development activities that are either ongoing (planned) or needed. These sheets are intended to be a visually appealing way to highlight technologies of interest and are shared with other DOE Sites, National Laboratories, and vendors as needed.

The catalog sheets make up Section 4.0 of this Roadmap. The TEDS sheets that are planned are “two pagers” showing activities and funding to support the technology development. The needed TEDS sheets are “one pagers” as they represent either unfunded high-priority TEDS sheets or needed technologies that have a lower priority. In some instances, medium- and low-priority TEDS sheets may be planned and, as such, have “two pagers” prepared for them.

The basis of estimate provide 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

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).

After catalog sheets are finalized, the Roadmap is compiled and released for use within the DOE complex. This compilation is a living document that is updated annually to accommodate the changing needs of Hanford Site cleanup. As such, it will be a key source for preparing out-year roadmaps.
4.0 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)
- Dispose Tank Waste (DTW)
- Manage Waste (MW).

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

- Planned
- Needed.

The planned catalog sheets are two pages. The designation of planned indicates an ongoing funded effort. The needed catalog sheets are one page. The designation of needed indicates a proposed technology that is currently unfunded. Each grouping of planned and needed catalog sheets are arranged alpha numerically within high, medium, and low subcategories.
4.1 Manage Tank Waste

The MTW function 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 direct-feed low-activity waste (DFLAW) initiative. WRPS plans to upgrade utilities, transfer lines, and support facilities to deliver low-activity waste (LAW) feed directly to the WTP LAW 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.
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 4.1.1 and 4.1.2 include the catalog sheets for the technologies that fall under the MTW function.
4.1.1 MTW Catalog Sheets – Planned

**RANKED HIGH**
- MTW-11 DST Primary Tank Bottom Volumetric Inspection .............................................4-4
- MTW-15 Visual Inspection of DST Primary Tank Bottoms ..............................................4-6
- MTW-24 Vapor Monitoring, Detection & Remediation (VMDR) .......................................4-8
- MTW-37 Tank Waste Characterization and Identification .................................................4-10
- MTW-41 Analytical Method Development for Compounds of Concern ..........................4-12
- MTW-79 Autonomous Instrumental Vehicle ....................................................................4-14

**RANKED MEDIUM**
- MTW-68 Mobile Proton Transfer Reaction – Mass Spectrometer ....................................4-16
- MTW-76 Online Monitoring using Raman Spectroscopy .................................................4-18
- MTW-77 Large-Volume Supernatant Sampler and Transportation System ......................4-20

**RANKED LOW**
- MTW-40 Improve Sampling Methods of Head Space ......................................................4-22
- MTW-69 Personal Ammonia Monitor ..............................................................................4-24
Currently, no technology is employed to interrogate the integrity of the primary tank bottom. Development and deployment of such a technology would provide quantitative data to validate tank integrity through inspection of a suspect region where degradation understanding is limited.

Development of volumetric inspection capability for the primary tank bottom of double-shell tanks is set to follow directly from initial visual inspection. An Expression of Interest (EOI) targeting the volumetric inspection challenge was issued by WRPS in parallel to the one for visual inspection.

The EOI solicited candidate sensor technologies to allow for volumetric inspection the primary tank bottom of our double-shell tanks. Vendor response was excellent, with 12 vendors submitting summaries of potential solutions to meet the challenge. Each of the vendors was invited to travel to Richland, present their sensor solution, and functionally demonstrate it on our characteristic mock-up. Of the 12 vendors who responded to the EOI, four had products readily available for demonstration and agreed to participate.
ADDITIONAL TECHNICAL INFORMATION

FY 2018 scope plans to develop 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.

COST AND SCHEDULE SUMMARY

WBS number: 5.01.01.05.20.01

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>2019</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Phase 2: Procurement, SOW Development, and Contract Placement with a chosen vendor</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Phase 2: Design/Fabricate/Test/Deliver</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Phase 2: Onsite Mock-Up Demonstration</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Phase 3: Field Work for In-Service Implementation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1010</td>
<td>$500</td>
<td>$1510</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-012, DST Availability to Perform Functions is LTA

Contractor Contact: **Jason Gunter**  
Phone: (509)376-0904  
Email: Jason_R_Gunter@rl.gov

DOE ORP Contact: **Dustin Stewart**  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
VISUAL INSPECTION OF DST PRIMARY TANK BOTTOMS

TEDS ID: MTW-15  Priority: High  Rank: 10

TECHNOLOGY NEED

Recommended by High-Level Waste Integrity Assessment Panel in its second workshop (RPP-ASMT-57582).

Recommended by the Independent Registered Professional Engineer of the Double-Shell Tank System Integrity Assessment (RPP-RPT-58441 Recommendation R16-4).

In general service, a refractory air slot visual inspection system would allow determination of condition of the refractory material towards the center bottom of the tank and visually observable condition of the bottom of the primary tank.

TECHNOLOGY SOLUTION

Primary tank bottom inspection is a primary focus of current development within WRPS through a partnership between the Tank and Pipeline Integrity and Chief Technology Office organizations. Prior to 2016, efforts to meet this inspection challenge have included vendor solicitation and market research through participation at industry conferences. In 2016, WRPS released an Expression of Interest (EOI) targeting deployment of an inspection system to visually examine the primary tank bottom through channels in the refractory pad the tank sits on. Seven vendors responded to the EOI and presented their approach to address the challenge at a meeting in Richland, Washington. The primary purpose of the forum was for the vendors to present their understanding of the challenge and how their capabilities could lend themselves to a functional solution. Primary tank bottom inspection crawlers from two vendors have been procured to deliver cameras systems within the refractory air slots under the double-shell primary tank.

Primary Tank Bottom Inspection Crawler
ADDITIONAL TECHNICAL INFORMATION

The information gathered supported development of a refined statement of work for formal proposals. These proposals were evaluated through a competitive bid process in early 2017 with two vendors being selected to take their design through fabrication, testing, delivery, and initial deployment. These two systems are nearly complete as of early FY 2018 with planned initial deployment in late FY 2018. This task is nearing completion.

CRAWLER TO DELIVER CAMERA SYSTEMS WITHIN REFRATORY AIR SLOTS

COST AND SCHEDULE SUMMARY

WBS number: 5.01.01.05.20.01

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY 2018</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Delivery</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Initial Field Deployment</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-010, Inability to Maintain Adequate DST Space

Contractor Contact:  
Jason Gunter  
Phone: (509)376-0904  
Email: Jason_R_Gunter@rl.gov

DOE ORP Contact:  
Dustin Stewart  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
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 vapor monitoring, detection and remediation system (VMDR) is a real-time system that includes the vapor monitoring an detection system (VMDS) and the NUCON Vapor Abatement Unit (NUCON). The VMDS characterizes the tank farms air space for potential harmful vapors; this system was pilot-tested in FY 2016/2017. The data/information gathered by the VMDS in conjunction with other related study and 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. The VAU provides filtration and destroys tank vapors.

TECHNOLOGY SOLUTION

Provide technology development to support the implementation of the recommended tank farm VMDS equipment/software. VMDS technologies include GPS (worker/equipment location); improved chemical and direct reading sensors (fixed/portable); spectroscopy monitors (ultraviolet Fourier transform infrared [UV-FTIR] stack monitor; open path Fourier transform infrared [OP-FTIR] and ultraviolet differential optical adsorption spectroscopy [UV-DOAS] area/fence line monitors); a meteorological station; and whole-air samplers (stack area and wearable).

Phase I pilot-scale testing was completed in FY 2017, and the report includes path forward recommendations for further development of key equipment (i.e., adding a gas chromatography flame ionization detection [GC-FID]) to the autosamplers and development of standalone N2O sensors and C2 sense personal samplers). WRPS plans to procure and develop these sensors in FY 2018 and implement them in the FY 2018/2019 timeframe.
### ADDITIONAL TECHNICAL INFORMATION

Phase I pilot-scale testing produced a host of viable technologies for transitions to WRPS tank farm projects for implementation. One result of the phase I pilot-scale testing was to modify the autosampler 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. Initiation of the autosampler development started in late FY 2017 and will continue through FY 2018. The results may be used to develop the field unit in FY 2019. In addition, the Autosampler is planned to be developed for use in tank farm area monitoring and for headspace sampling/analysis.

### COST AND SCHEDULE SUMMARY

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>2019</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Pilot Scale Testing</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Deployment</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>1500</td>
<td>1500</td>
<td>3,000</td>
</tr>
</tbody>
</table>

The above cost and schedule summary only applies to VDMS. Cost and schedule summaries for other technologies will be provided in future datasheets.

### RISKS AND OPPORTUNITIES

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes
TANK WASTE CHARACTERIZATION AND IDENTIFICATION

TEDS ID: MTW-37        Priority: High        Rank: 30

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 TOC mission. Improved technologies enhance the detection and identification of solid phases 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

A new x-ray diffraction (XRD) machine is needed to overcome analytical shortcomings of the existing XRD at the 222-S Laboratory. The existing instrument includes minimal measurement and calibration capability. The desired XRD is a more scientifically capable instrument incorporating 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. At the same time, 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 (e.g., phase quantification and/or crystal structure refinement).

An Fourier transform infrared (FTIR) with infrared microscope and TGA has been acquired: installation in the 222-S Laboratory is scheduled for completion in FY 2018. Process analyses and procedure development is planned in 2019. Complementary Raman micro-spectroscopy is needed to aid the identification of molecular constituents, based on vibrational frequencies of the chemical bonds and bond energies.
**ADDITIONAL TECHNICAL INFORMATION**

- **Proposed X-Ray Diffractometer**
- **Proposed Raman Microscopy**
- **New FTIR and Infrared Microscope**

**COST AND SCHEDULE SUMMARY**

WBS number: N/A

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>XRD acquisition and use</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>$</td>
</tr>
<tr>
<td>FTIR installation and use</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>$</td>
</tr>
<tr>
<td>Raman acquisition and use</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>$</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$400</td>
<td>$1,000</td>
<td>$400</td>
<td>$125</td>
<td>$1,925</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RISKS AND OPPORTUNITIES**

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

**Contractor Contact:**
- **Gary Cooke**
  - Phone: (509)373-2154
  - Email: Gary_Cooke@rl.gov

**DOE ORP Contact:**
- **Jeff Cheadle**
  - Phone: (509)376-0755
  - Email: Jeffry_E_Cheadle@orp.doe.gov
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 compounds of concern (COC) contains many compounds 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
ADDITIONAL TECHNICAL INFORMATION

Many compounds are not available as pure analytes, which precludes development of calibrated methods of analyses. This lack of standard reference materials may be addressed by finding alternative suppliers or determining an indirect approach to calibration. However, the principal hindrance to expansion of the calibrated COC list is the lack of staff time to identify method improvements and to develop new analytical methods.

Lastly, testing and evaluation is needed to determine whether alternative analytical approaches (e.g., high-pressure liquid chromatography), that may be more appropriate for analyses of some compounds. Resources at National Laboratories could provide additional method development, particularly for the organonitrate and organonitrite groups of COCs.

COST AND SCHEDULE SUMMARY

WBS number: N/A

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018 Q1</th>
<th>2019 Q1</th>
<th>2019 Q2</th>
<th>2019 Q3</th>
<th>2019 Q4</th>
<th>2020 Q1</th>
<th>2020 Q2</th>
<th>2020 Q3</th>
<th>2020 Q4</th>
<th>2021 Q1</th>
<th>2021 Q2</th>
<th>2021 Q3</th>
<th>2021 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical Method Development</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$1,500</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$250</td>
<td>$750</td>
<td>$500</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$1,500</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: Paul Gassman  
Phone: (509)373-3401  
Email: Paul_L_Gassman@rl.gov

DOE ORP Contact: Jeffry Cheadle  
Phone: (509)376-0755  
Email: Jeffry_E_Cheadle@orp.doe.gov
AUTONOMOUS INSTRUMENTED VEHICLE

TEDS ID: MTW-79  Priority: High    Rank: 2

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.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No
ADDITIONAL TECHNICAL INFORMATION

Onscreen Image of Positioning Data from the Autonomous Instrumented Vehicle

COST AND SCHEDULE SUMMARY

WBS numbers: 5.3.1.7.3.13 and 5.1.5.11.65

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018 Q1</th>
<th>2018 Q2</th>
<th>2018 Q3</th>
<th>2018 Q4</th>
<th>2019 Q1</th>
<th>2019 Q2</th>
<th>2019 Q3</th>
<th>2019 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIV Development</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$49</td>
</tr>
<tr>
<td>Development and Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$200</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$49</td>
<td>$200</td>
<td>$249</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: Kayle Boomer
Phone: (509)372-3629
Email: Kayle_D_Boomer@rl.gov

DOE ORP Contact: Jeremy Johnson
Phone: (509)376-1899
Email: Jermey_M_Johnson@orp.doe.gov
MOBILE PROTON TRANSFER REACTION – MASS SPECTROMETER

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

TECHNOLOGY NEED

Real-time characterization of the tank farm air space for potential harmful vapors using the mobile analytical laboratory (Mobile Lab) is planned for implementation to support establishing unrestricted work boundaries and facilitate managing operational activities and responses. Understanding/analyzing these conditions is expected to enhance tank farm work planning and mitigate worker exposures.

TECHNOLOGY SOLUTION

Evaluate the utility of using a proton transfer reaction – mass spectrometer (PTR-MS) mounted in a Mobile Lab to analyze for potential tank vapor concentrations in worker breathing spaces, exhausters, passive breather filters, etc. to support the Comprehensive Vapor Action Plan. Function and requirement parameters for stack and corridor monitoring will be defined and established utilizing knowledge gained from the PTR-MS Mobile Lab, vapor monitoring and detection system (VMDS) pilot test, and industrial hygiene program enhancements. In FY 2018, enhancement of the Mobile Lab instrumentation is anticipated (i.e., addition of a ultraviolet Fourier transform infrared [UV-FTIR] stack monitor to provide measurement of mercury and nitrous oxide, as well as addition of an real-time detecting optimized sample selection auto sampler). Continued operation of the mobile laboratory to supplement the capabilities of the vapor monitoring and detection system, respond to AOP-015 events, do background level assessments and monitor air quality during waste-disturbing events is expected for the foreseeable future.
**ADDITIONAL TECHNICAL INFORMATION**

This technology can assist tank farms operations by providing required monitoring of active stack ventilation and unrestricted work areas around the tank farms. Implement monitoring for all A Tank Farms (A, AN, AP, AW, AX, AY, and AZ) and provide measurement of compounds of concern background levels across the 200 Area plateau.

**COST AND SCHEDULE SUMMARY**

WBS number: 5.1.5.11.50.6

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>2019</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Technology Demonstration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

**Contractor Contact:** George Weeks  
Phone: (509)376-7879  
Email: George_E_Weeks@rl.gov

**DOE ORP Contact:** James Lynch  
Phone: (509)376-4170  
Email: James_J_Lynch@orp.doe.gov
ONLINE MONITORING USING RAMAN SPECTROSCOPY

TEDS ID: MTW-76  
Priority: Medium  
Rank: N/A

TECHNOLOGY NEED

Waste Treatment and Immobilization Plant and direct-feed low-activity waste operations is 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.

Sample Raman Spectrum

---

Technology Maturation Level:
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes
ONLINE MONITORING USING RAMAN SPECTROSCOPY

ADDITIONAL TECHNICAL INFORMATION


COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03.13

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>System Design</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Predictive Model Formulation and</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Simulant Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Real Waste Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Field Deployable System</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$275</td>
<td>$175</td>
<td>$300</td>
<td>$750</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: Amie Kim
Phone: (509)376-2309
Email: Amie_J_Kim@rl.gov

DOE ORP Contact: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
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.

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 are 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.
ADDITIONAL TECHNICAL INFORMATION


COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18 Q1</th>
<th>FY18 Q2</th>
<th>FY18 Q3</th>
<th>FY18 Q4</th>
<th>FY19 Q1</th>
<th>FY19 Q2</th>
<th>FY19 Q3</th>
<th>FY19 Q4</th>
<th>FY20 Q1</th>
<th>FY20 Q2</th>
<th>FY20 Q3</th>
<th>FY20 Q4</th>
<th>FY21 Q1</th>
<th>FY21 Q2</th>
<th>FY21 Q3</th>
<th>FY21 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shielded Sampler and Hedgehog III Design</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$900</td>
</tr>
<tr>
<td>Shielded Sampler Fabrication and Functional Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$900</td>
</tr>
<tr>
<td>Hedgehog III Fabrication and Functional Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$900</td>
</tr>
<tr>
<td>Deploy in field</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>$1600+</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$450</td>
<td>$550</td>
<td>$600</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$TBD</td>
<td>$1600+</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-027, LAWPS Product Output Does Not Meet the Design Expectations of WTP LAW WAC

Contractor Contact:  
Amie Kim  
Phone: (509)376-2309  
Email: Amie_J_Kim@rl.gov

DOE ORP Contact:  
Dustin Stewart  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
IMPROVE SAMPLING METHODS OF HEAD SPACE PARTICULATES

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.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No
ADDITIONAL TECHNICAL INFORMATION

COST AND SCHEDULE SUMMARY

WBS number: 5.1.3.3.5.1

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>Design/build sampler</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Field Test</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>250</td>
<td>500</td>
<td>500</td>
<td>1250</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

**Contractor Contact:** Paul Gassman  
Phone: (509)373-3401  
Email: Paul_L_Gassman@rl.gov

**DOE ORP Contact:** James Lynch  
Phone: (509)376-4170  
Email: James_J_Lynch@orp.doe.gov
PERSONAL AMMONIA MONITOR

HANFORD SITE
US DEPT OF ENERGY

PLANNED

This personal ammonia monitor uses a single-wall carbon nanotube technology to monitor ammonia levels. It would be worn by all tank farm workers and be capable of reporting ammonia concentrations to the Central Shift Office in real-time.

TECHNOLOGY NEED

Real-time characterization of the tank farm worker breathing air space for potential chemical vapors using the C2Sense sensor is planned to be implemented to support the establishment of unrestricted work boundaries and facilitate managing operational activities and responses. Understanding/analyzing these conditions is expected to enhance tank farm work planning and mitigate potential worker exposures.

TECHNOLOGY SOLUTION

This monitor would be worn by all tank farm workers while they are in the tank farm. The sensor is based on single-wall carbon nanotube technology. The carbon nanotubes are treated with a sensitizing compound and integrated on a substrate to produce a chemiresister. The chemiresister resistance varies with concentration of the analyte, in this case ammonia. This technology has demonstrated subparts per million sensitivity to ammonia in laboratory conditions. Tests were successfully conducted that demonstrated sensor performance using vapors collected from AP stack emissions. This technology provides an inexpensive method to monitor the ammonia exposure for each tank farm worker in real-time. A local alarm notifying workers to take protective action if the concentration reaches a pre-defined exposure threshold.

Technology Maturation Level.
Prototype

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

C2Sense Personal Monitor Prototype
ADDITIONAL TECHNICAL INFORMATION

Prototype development was completed at C2Sense facilities in Boston, Massachusetts in FY 2017. A field trial of the prototype sensors delivered in FY 2017 is planned for FY 2018.

C2Sense Sensor Chip

COST AND SCHEDULE SUMMARY

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Field Evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$350</td>
<td>$350</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: George Weeks  
Phone: (509)376-7879  
Email: George_E_Weeks@rl.gov

DOE ORP Contact: James Lynch  
Phone: (509)376-4170  
Email: James_J_Lynch@orp.doe.gov
4.1.2 MTW Catalog Sheets – Needed

**RANKED HIGH**
- MTW-09 Automated DST Annulus Camera System .................................. 4-27
- MTW-57 Predicting Behavior of Mercury in EMF .................................. 4-28
- MTW-73 Tertiary Leak Detection & Foundation Robotic Inspection ........ 4-29
- MTW-74 Measure Breathing Rates in Selected SX Tanks ....................... 4-30
- MTW-75 Super-Hydrophobic Metal Surface to Reduce Equipment Contamination ... 4-31
- MTW-81 Radiation Tolerant Multi-Use Manipulator System ................. 4-32
- MTW-82 Tank Annulus Floor Cleaning .................................................. 4-33

**RANKED MEDIUM**
- MTW-10 Electromagnetic Acoustic Transducer and Phased Array .......... 4-34
- MTW-13 Improve Liquid Observation Well Data Acquisition .................. 4-35
- MTW-20 Upgrade Still and Video System for Tank Inspection ............... 4-36
- MTW-36 Slurry Property Investigation .................................................. 4-37
- MTW-50 Retrieval Support System ....................................................... 4-38
- MTW-66 Treatment of NDMA at the Source .......................................... 4-39
- MTW-70 Plutonium Particulate Criticality Safety Issue Resolution .......... 4-40
- MTW-71 Improve Best-Basis Inventory with TWINS Database ............. 4-41
- MTW-72 Self-Diagnosing Continuous Air Monitoring ......................... 4-42
- MTW-78 In-Tank Volumetric Nondestructive Examination ................... 4-43
- MTW-80 Automated Visual Recognition Wireless Remote Video Monitoring .... 4-44

**RANKED LOW**
- MTW-12 Improve Annulus Air Monitoring ............................................. 4-45
- MTW-59 High Silica-Containing PPE .................................................... 4-46
NEEDED

"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 NEED

The High-Level Waste Integrity Assessment Panel recommended in its second workshop (RPP-ASMT-57582) 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 provided 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, and this would increase video review efficiency.

RISKS AND OPPORTUNITIES

RPP-012, DST Availability to Perform Functions is LTA

Contractor: Joel Larson  
Phone: (509)373-9351  
Email: Joel_D_Larson@rl.gov

ORP: Dustin Stewart  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
PREDICTING BEHAVIOR OF MERCURY IN EMF

TEDS ID: MTW-57  Priority: High  Rank: 31

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 HgCl2 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.

RISKS AND OPPORTUNITIES

RPP-002, 242-A Evaporator Does Not Achieve Planned Waste Volume Reduction
RPP-062, New Interpretation of Existing Regulations

Contractor: Jacob Reynolds  Phone: (509)373-5999  Email: Jacob_G_Reynolds@rl.gov
ORP: Elaine Diaz  Phone: (509)373-9757  Email: Elaine_N_Diaz@orp.doe.gov
TERTIARY LEAK DETECTION & FOUNDATION ROBOTIC INSPECTION

TEDS ID: MTW-73  Priority: High  Rank: 5

TECHNOLOGY NEED

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

A drain line crawler deployed in the AN or AW Tank Farms would allow for visual inspection of the underside of the 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 tanks to investigate the condition of the underside of the secondary liner.

RISKS AND OPPORTUNITIES

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate
RPP-014, WFD Does Not Meet the WRP PT WAC

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost?
$1-$5 Million

Contractor: Natalie Young
Phone: (509)376-6842
Email: Natalie_M_Young@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
MEASURE BREATHING RATES IN SELECTED SX TANKS

TEDS ID: MTW-74
Priority: High
Rank: 25

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 SF6) 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

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

Contractor: John Schofield
Phone: (509)373-6104
Email: John_S_Schofield@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
### 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

Using femtosecond lasers to etch nanostructures onto a surface adds hydrophobic properties that are permanent and intrinsic to the metal surface. The hydrophobic properties of the surface structure are extremely strong. The following tasks would assess viability:

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

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

**Contractor:** Jonathan Barnes  
**Phone:** (509)373-3755  
**Email:** Johnathan_E_Barnes@rl.gov

**ORP:** Elaine Diaz  
**Phone:** (509)373-9757  
**Email:** Elaine_N_Diaz@orp.doe.gov
RADIATION TOLERANT MULTI-USE MANIPULATOR SYSTEM

TEDS ID: MTW-81  |  Priority: High  |  Rank: 23

TECHNOLOGY NEED

The complexity of the 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 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 SSTs 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 WTP.

Technology Maturation Level.
Modify Existing Technology

National Laboratory Involvement?
No

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost?
<$1 Million

Contractor: Kayle Boomer
Phone: (509)372-3629
Email: Kayle_D_Boomer@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov

RISKS AND OPPORTUNITIES

N/A
In 2002 the primary tank walls of AY-101 were cleaned by a contractor 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 is now causing problems for ultrasonic inspection and annulus level monitoring.

Due to the corrosion product and debris on the annulus floor the ultrasonic inspection crawler is not able to inspect large portions of the annulus floor, and the Enraf is prevented from making contact with the annulus floor rendering it ineffective for level monitoring.

Projects to develop a system for removal of the debris buildup in tank AY-101 would have the benefit of providing more annulus floor area for visual and nondestructive examination as well as prevent impact to Enraf calibration within the tank AY-101 annulus. This system would mechanically move the debris and/or remove it from the annulus space via containers. Methods to do so would be proposed by vendors, with several candidate options being push blades, scoops, or vacuum attachments for material capture. Deployment through 12-in. and 24-in. riser dimensions is a requirement to meet the tools objective.

N/A

Contractor: Joel Larson
Phone: (509)373-9351
Email: Joel_D_Larson@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
ELECTROMAGNETIC ACOUSTIC TRANSUDER AND PHASED ARRAY

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 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

The electromagnetic acoustic transducer (EMAT) system provides a method to rapidly detect localized areas of concern in the tank material. Any areas of concern would then be interrogated with the more precise and slower P-Scan™ ultrasonic testing method. WRPS worked with Pacific Northwest National Laboratory in 2014 to procure and test an EMAT system, and this system was deployed in tank AP-102 during normal ultrasonic testing operations. Mill-scale on the wall impacted the results. Strategies were evaluated by the laboratory to compensate for the mill-scale effect and results were promising on a laboratory scale, but additional work is needed.

RISKS AND OPPORTUNITIES

RPP-012, DST Availability to Perform Functions is LTA

Contractor: Jason Gunter  Phone: (509)376-0904  Email: Jason_R_Gunter@rl.gov
ORP: Dustin Stewart  Phone: (509)376-8950  Email: Dustin_M_Stewart@orp.doe.gov
IMPROVE LIQUID OBSERVATION WELL DATA ACQUISITION

TEDS ID: MTW-13  Priority: Medium  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 four 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

RPP-012, DST Availability to Perform Functions is LTA
HANFORD SITE
US DEPT OF ENERGY

NEEDED

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 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 (<~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.

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

RPP-012, DST Availability to Perform Functions is LTA

Contractor: Joel Larson  ORP: Jeremy Johnson
Phone: (509)373-9351  Phone: (509)376-1866
Email: Joel_D_Larson@rl.gov  Email: Jeremy_M_Johnson@orp.doe.gov

Rough Order of Magnitude Cost? $1-$5 Million
SLURRY PROPERTY INVESTIGATION

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 which 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.

RISKS AND OPPORTUNITIES

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

Contractor: Gary Cooke  Phone: (509)373-2154  Email: Gary_Cooke@rl.gov

ORP: Jeffry Cheadle  Phone: (509)376-0755  Email: Jeffry_E_Cheadle@orp.doe.gov
**RETRIEVAL SUPPORT SYSTEM**

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

**TECHNOLOGY NEED**

Currently, single-shell tank 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**

RPP-010, Inability to Maintain Adequate DST Space

---

**Technology Maturation Level.**  
Research and Concept

**National Laboratory Involvement?**  
Yes

**Submitted as Grand Challenge?**  
No

**Rough Order of Magnitude Cost?**  
$1-$5 Million

**Contractor:**  
Matt Landon  
Phone: (509)373-1379  
Email: Mathew_R_Landon@rl.gov

**ORP:**  
Dustin Stewart  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
TREATMENT OF NDMA AT THE SOURCE

TEDS ID: MTW-66  Priority: Medium  Rank: N/A

TECHNOLOGY NEED

NDMA (n-nitrosodimethylamine) is the only compound of concern with a significant concentration compared to the operational exposure limit in tanks where retrievals are planned or are ongoing. NDMA is only significant in a few of those tanks. A method to treat it locally, rather than applying other engineered solutions to all ventilation systems (e.g., diluting with fans or extending stacks), may be a more affordable and sustainable approach.

TECHNOLOGY SOLUTION

Because NDMA rapidly breaks down in ultraviolet light, a study is recommended with a follow-on bench-scale test by Savannah River National Laboratory. That laboratory already has a ultraviolet test stand previously used to study ammonia treatment options.

RISKS AND OPPORTUNITIES

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

Ultra Violet Light Unit

Contractor: Jason Vitali  
Phone: (509)376-6751  
Email: Jason_R_Vitali@rl.gov

ORP: Elaine Diaz  
Phone: (509)373-9757  
Email: Elaine_N_Diaz@orp.doe.gov
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.

A criticality safety control strategy for plutonium (Pu) particulates may be required for retrieval, mixing, and transfer of radioactive wastes to the Waste Treatment and Immobilization Plant (WTP). As high-level waste sludge is moved through the double-shell tank system, criticality safety issues must be addressed in criticality evaluations.

Unexpected tank conditions (e.g., leakage) might also necessitate criticality evaluations. An evaluation is needed to determine the physical characteristics of Pu-Bi in tank waste. Details about this need are in the One System report on Pu particulate criticality safety issue resolution (RPP-RPT-56983).

Three evaluations are identified:

1. Perform characterization of bismuth phosphate and Plutonium Finishing Plant process waste archived samples to determine if Pu-Bi or other particulate Pu phases are present.
2. Determine density and conditions of formation of Pu particulate by transmission electron microscopy (TEM) characterization of observed PuO2, Pu-Bi, and Pu-Bi-PO4 forms.
3. Determine density and conditions of formation of the Pu-Bi compounds by synthesis to match the TEM analysis. The purpose of this testing is to understand whether compounds matching those expected to form in the waste can be synthesized under conditions in the bismuth phosphate process (i.e., B Plant, T Plant).

Risks and Opportunities

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate
RPP-014, WFD Does Not Meet the WRP PT WAC
**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; and 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, and 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 and deploy upgrades.

**RISKS AND OPPORTUNITIES**

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate
SELF-DIAGNOSING CONTINUOUS AIR MONITORING

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

TECHNOLOGY NEED

Continuous air monitors (CAM) 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

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

Contractor: Mark Garrett  Phone: (509)373-2319  Email: Mark_S_Garrett@rl.gov
ORP: Dustin Stewart  Phone: (509)376-8950  Email: Dustin_M_Stewart@orp.doe.gov
IN-TANK VOLUMETRIC NONDESTRUCTIVE EXAMINATION

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 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. 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.

RISKS AND OPPORTUNITIES

RPP-010, Inability to Maintain Adequate DST Space

Contractor:  Steve Kelly  Phone:  (509)376-0717  Email:  Steven_E_Kelly@rl.gov
ORP:  Dustin Stewart  Phone:  (509)376-8950  Email:  Dustin_M_Stewart@orp.doe.gov
## TECHNOLOGY NEED

Hanford 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.

### Technology Maturation Level
- Modify Existing Technology

### National Laboratory Involvement?
- Yes

### Submitted as Grand Challenge?
- Yes

### Rough Order of Magnitude Cost?
- <$1 Million

### CONTRACTOR: Jason Vitali
- Phone: (509)376-6751
- Email: Jason_R_Vitali@rl.gov

### ORP: Elaine Diaz
- Phone: (509)373-9757
- Email: Elaine_N_Diaz@orp.doe.gov

### RISKS AND OPPORTUNITIES

A/AX-77, Tank Vapors Result in Unanticipated Work Stoppages
IMPROVE ANNULUS AIR MONITORING

TEDS ID: MTW-12  Priority: Low  Rank: N/A

TECHNOLOGY NEED

To improve the current continuous air monitor (CAM) system, modifications to the exhaust risers and CAM sample locations would be required. Problems with the current system likely relate to inadequate particle entrainment in flow and friction losses in the exhaust header through the flow path. That is to say that radioactive particles cannot be confidently uplifted by the reduced annulus ventilation velocity to the riser penetration and upon entry into the system. Inherent friction within the extensive exhaust header presents resistance to flow that may hinder collection of particles on the upstream CAM system.

TECHNOLOGY SOLUTION

Evaluate annulus leak detection improvement scope, design, build, and test a prototype improved CAM leak detection system that applies to any size and duration of a tank leak.

RISKS AND OPPORTUNITIES

RPP-012, DST Availability to Perform Functions is LTA
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 Maturation Level.
Prototype

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost?
<$1 Million

Technology Solution

Some commercial zeolites have been proven effective at removing nitrosamines from such complex vapor mixtures as tobacco smoke. Tobacco smoke 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). 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

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

Contractor: Jason Vitali
Phone: (509)376-6751
Email: Jason_R_Vitali@rl.gov

ORP: James Lynch
Phone: (509)376-4170
Email: James_J_Lynch@orp.doe.gov
4.2 Retrieve Tank Waste

Waste retrieval 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. Waste retrieval 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 various waste treatment facilities (e.g., Low-Activity Waste Pretreatment System [LAWPS], Tank-Side Cesium Removal [TSCR], WTP). The near-term DST waste transfer strategy focuses on startup, commissioning, and initial operation of DFLAW, 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 4.2.1 and 4.2.2 include the catalog sheets for the technologies that fall under the RTW function.
4.2.1 RTW Catalog Sheets – Planned

**RANKED HIGH**
- RTW-01 Development of Next Generation Retrieval Waste Sampling Tools ............ 4-50
- RTW-08 In-Tank Mechanical Waste Gathering System ........................................... 4-52
- RTW-24 Two-Step Characterization of 241-C-301 Catch Tank Content ................. 4-54
- RTW-25 Highly Flowable Grout ............................................................................. 4-56
- RTW-55 Hanford Waste End Effector ...................................................................... 4-58

**RANKED MEDIUM**
- RTW-12 Development of Rotary Core Cutting System ........................................... 4-60
This page intentionally left blank.
### NEXT GENERATION RETRIEVAL WASTE SAMPLING TOOLS

<table>
<thead>
<tr>
<th>TEDS ID: RTW-01</th>
<th>Priority: High</th>
<th>Rank: 32</th>
</tr>
</thead>
</table>

#### TECHNOLOGY NEED

Tank closure requires sampling of residual tank waste. Currently none of the existing sampling methods are able to reliably collect hard heel material that is not directly under the tank riser. The current system is a General Electric Inspection Technology (GEIT) V3020-6310 crawler and V9500-4001 sample scoop. The sample scoop (clamshell) design is not strong enough to break off a piece of hard heel for sampling without additional mechanical support from the sample crusher (tenderizer).

An off-riser sampler system (ORSS) would allow collection of hard-heel samples away from the tank riser.

#### TECHNOLOGY SOLUTION

Conduct a workshop with the nine companies that submitted proposals to the ORSS Expression of Interest. Review proposals and down-select an option or options for cold testing. Characterize the tank hard heel composition and specify an applicable simulant to enable better cold testing.
RPP-PLAN-43988, Rev. 4

NEXT GENERATION RETRIEVAL WASTE SAMPLING TOOLS

ADDITIONAL TECHNICAL INFORMATION

TEDS ID: RTW-01 Continued

Previous Sampling Auger

Sample Tenderizer (RPP-STE-00087)

COST AND SCHEDULE SUMMARY

WBS number: 5.02.01.02.01

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Design</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Fabrication</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Deployment</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$200,000</td>
<td>$150,000</td>
<td>$350,000</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes
RPP-054, Facility Closure Costs Are Not Fully Evaluated

Contractor Contact: Thomas Myer
Phone: (509)373-3126
Email: Thomas_G_Myer@rl.gov

DOE ORP Contact: Jeffrey Rambo
Phone: (509)376-4997
Email: Jefferey_J_Rambo@orp.doe.gov
A technology is needed for retrieving solids from Hanford Site tanks that contain primarily solids (sludge, salt cake, and hard pan). An alternative to the vacuum-mode mobile arm retrieval system (MARS-V) is needed to complete A and AX Tank Farms retrievals by March 31, 2024, and other future retrievals. In many SSTs, it is undesirable to use sluicing liquids to break up and remove waste due to the known or suspected integrity of the tanks.

The mechanical waste gathering system (MWGS) originating from a 2017 Grand Challenge 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, and development efforts continue. The system will leverage industry knowledge and experience, demonstrate MWGS effectiveness using a test facility, identify and develop supporting systems, and finally undergo robust testing at higher quality levels for Hanford Site deployment. 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.
IN-TANK MECHANICAL WASTE GATHERING SYSTEM

ADDITIONAL TECHNICAL INFORMATION

To date the TOC has utilized: modified sluicing; enhanced sluicing, extended reach sluicing system; salt cake dissolution; and the MARS-V. 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.

Mechanical Waste Gathering System

COST AND SCHEDULE SUMMARY

WBS number: 5.03.01.07.03.13

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>Phase II – Prototype Development &amp; Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Phase III – Integrated System Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$670</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$4,670</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: Thomas Myer
Phone: (509)373-3126
Email: Thomas_G_Myer@rl.gov

DOE ORP Contact: Jeffrey Rambo
Phone: (509)376-4997
Email: Jefferey_J_Rambo@orp.doe.gov
TECHNOLOGY NEED

A sampling technology is needed to support Waste Management Area C closure required under Tri-Party Agreement Milestone M-045-83. There is no current alternative to this technology, which would support a risk-based retrieval decision in the timeframe supported by this technology. (Note that because no volume-based retrieval goal has been established for the C-301 catch tank, having risk data available to support the retrieval goal is important.) The closest technology would be the rotary core system, which would not allow the collection of the waste penetration-resistance and geophysical logging data supported here. The rotary core system would also be more costly and may not be available due to the need to perform higher priority sampling of double-shell tanks.

TECHNOLOGY SOLUTION

The current approach is to develop push mode sampling technology specifically to address characterization and retrieval of the C-301 catch tank. The technology could be further developed to provide data to support retrieval designs by evaluating small-diameter logging tools that are available or could be available and determining how that data could be used.
TWO-STEP CHARACTERIZATION OF 241-C-301 CATCH TANK CONTENT

ADDITIONAL TECHNICAL INFORMATION

The technology may have application for sampling other small tanks in and around tank farms and throughout the Hanford Site.

Catch Tank C-301 Sketch

COST AND SCHEDULE SUMMARY

WBS number: 5.2.5.6.20.2

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1 Q2</td>
<td>Q3 Q4</td>
<td>Q1 Q2</td>
</tr>
<tr>
<td>Develop and deploy sampling technology</td>
<td>☐</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☒</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$900</td>
<td>$500</td>
<td>$1400</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-023, IMUST and MUST Closure Differs from Plan

Contractor Contact:  
Dan Parker  
(509)372-0766  
Danny_L_Parker@rl.gov

DOE ORP Contact:  
Jan Bovier  
(509)376-9630  
Jan_B_Bovier@orp.doe.gov
HIGHLY FLOWABLE GROUT

TEDS ID: RTW-25  Priority: High  Rank: 27

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. WRPS, DOE, and Ecology staff will be involved in the development of grout testing plans to ensure that their concerns are addressed to the extent practicable.

Typical Grout Drop Trench

Grout Testing
ADDITIONAL TECHNICAL INFORMATION

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 the development of the grout test report (RPP-RPT-41550).
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.
4. Test initial grout formulations and sealing technologies at bench scale.
5. Refine formulations and conduct additional bench scale testing if needed.
6. Conduct large-scale testing using a mocked-up pipe encasement(s).

COST AND SCHEDULE SUMMARY

WBS number: 5.02.05.06.24.02

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Develop and test grout formulations.</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Funding in thousands (000s) $900 $900

RISKS AND OPPORTUNITIES

RPP-054, Facility Closure Costs Are Not Fully Evaluated
HANFORD WASTE END EFFECTOR

TEDS ID: RTW-55  Priority: High  Rank: 22

TECHNOLOGY NEED

The potential key attributes for retrieval are based upon unique features of several SSTs that are known leakers. These unique features include a major tear in the bottom of tank A-105, which necessitates technologies other than past-practice sluicing to be deployed to prevent further intrusion of waste into the vadose zone. In addition, significant in-tank hardware makes some tanks more challenging.

TECHNOLOGY SOLUTION

The Hanford waste end effector (HWEE) is planned to be developed with the known challenges in mind.

- Phase I, HWEE Development – Select the most promising end effector for confined sluicing to meet goals of reduced liquid usage and retrieval performance, select suitable simulants for Phase I testing, fabricate the selected end effector, and conduct testing to quantify the effectiveness of the selected end effector. This was completed in FY 2017.
- Phase II, HWEE Integrated System Development – Test an integrated system that includes supporting equipment necessary to convey collected simulated waste from the end effector out of a tank and then transfer it to a selected destination; identify and develop systems to position the end effector, including the ability to avoid expected obstructions in an SST; and demonstrate the effectiveness of the integrated HWEE system. To be completed in FY 2018.

National Laboratory Involvement?  Yes

Submitted as Grand Challenge?  No
ADDITIONAL TECHNICAL INFORMATION

- Phase III, Full-Scale HWEE System Cold Testing – Demonstrate effectiveness of a complete integrated HWEE system at full-scale with simulants. To be completed in FY 2019.
- Phase IV, HWEE System Retrieval Project Deployment – Deploy and demonstrate HWEE system in an SST for retrieving remaining waste. To be completed in FY 2020.

COST AND SCHEDULE SUMMARY

WBS number: 5.3.1.7.3

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Phase 2) HWEE system development</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>$418</td>
</tr>
<tr>
<td>(Phase 3) Full scale Cold testing</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>$1,500</td>
</tr>
<tr>
<td>(Phase 4) Deployment in SSTs</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>$2,500</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$418</td>
<td>$1,500</td>
<td>$2,500</td>
<td>$4,418</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: Theodore Wooley
Phone: (509)372-1617
Email: Theodore_A_Wooley@rl.gov

DOE ORP Contact: Jeffery Rambo
Phone: (509)376-4997
Email: Jeffrey_J_Rambo@orp.doe.gov
DEVELOPMENT OF ROTARY CORE CUTTING SYSTEM

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 is an ALARA-based system that can provide a more efficient method to install a riser in support of tank waste retrieval. The installation is intended to minimize the need to remove existing equipment and allow installation of additional access for other new retrieval equipment.

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 a design concept for a mobile rotary core drilling system that is capable of installing (<60 in.) risers in SSTs. 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.
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.

COST AND SCHEDULE SUMMARY

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Dome load analysis</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Specification, SOW, and Contract</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Concept Development, Design, and Equipment procurement</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Fabrication, Testing, and Delivery</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1700</td>
<td>$1750</td>
<td>$3450</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes
RPP-019, CH-TRU Waste Treatment Throughput Rate is LTA

Contractor Contact: Thomas Myer
Phone: (509)373-3126
Email: Thomas_G_Myer@rl.gov

DOE ORP Contact: Jeffrey Rambo
Phone: (509)376-4997
Email: Jefferey_J_Rambo@orp.doe.gov
4.2.2  RTW Catalog Sheets – Needed

RANKED HIGH
RTW-02  Residual Volume Measuring System (RVMS) .......................................................... 4-63
RTW-39  Risk Informed Tank Retrieval Strategy ...................................................................... 4-64
RTW-53  Three-Dimensional Flash LIDAR to Map Waste Tanks ........................................... 4-65
RTW-54  Tank Waste Modular Treatment Study ....................................................................... 4-66
RTW-56  Technology to Support Risk-Based Retrieval and Closure ......................................... 4-67

RANKED MEDIUM
RTW-03  Remote Tank Farms Above Ground Inspections ......................................................... 4-68
RTW-07  Post Waste Retrieval Updates to WMA C PA and Long-Term Maintenance ... 4-69
RTW-11  Development of Portable Gamma Radiation Monitoring System .............................. 4-70
RTW-27  Improved Solubility Modeling of Aluminum ................................................................. 4-71
RTW-28  Improved Solubility Modeling of Oxalate, Fluoride and Other Simple Mixtures ...................................................................................................................... 4-72
RTW-29  Improved Solubility Modeling of Phosphate ............................................................... 4-73
RTW-32  Use of Neutron Poisons for Criticality Safety of Particulate Plutonium .............. 4-74
RTW-34  Extended Reach Sluicing System Modifications ........................................................... 4-75
RTW-43  Computer Simulator to Measure Retrieval Operator Skills ..................................... 4-76
RTW-44  Use of Sonar and Ultrasound to Quantify Solids in DSTs ....................................... 4-77
RTW-52  Barrier Technology Research ...................................................................................... 4-78

RANKED LOW
RTW-04  Prototype Beta Detection Probe Designed for Soil Contamination ...................... 4-79
RTW-10  Development Testing of High-Radiation Hose Materials ........................................ 4-80
RTW-15  Evaluate Back-Up Options for HLW Delivery from Tank Farms .............................. 4-81
RTW-16  Develop an Integrated HLW Feed Qualification Plan ............................................ 4-82
RTW-17  Access Deep Sludge Pump Reliability for DST Mixer and Transfer Pumps ........ 4-83
RTW-18  Improved Heat Removal for AW and AN Tanks TSR Heat Limits ........................ 4-84
RTW-19  TRU/SR-90 Precipitation in Double-Shell Tanks ...................................................... 4-85
RTW-21  Improve ESP – A Thermodynamic Modeling Program .............................................. 4-86
RTW-23  Waste Transfer Pipe Unplugging .............................................................................. 4-87
RTW-31  In-Tank Sampling Technologies for Plutonium Particles ....................................... 4-88
RTW-33  Instrumentation for Detecting Plutonium Accumulations in Tasks ....................... 4-89
RESIDUAL VOLUME MEASURING SYSTEM (RVMS)

TEDS ID: RTW-02  
Priority: High  
Rank: 28

TECHNOLOGY NEED

Accessibility to 12-in. risers is limited; therefore, a smaller system 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

An Expression of Interest and technology research efforts have been performed to locate applicable technological applications. Feasible technologies are planned for testing in a tank farm tank.

RISKS AND OPPORTUNITIES

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes  
RPP-054, Facility Closure Costs Are Not Fully Evaluated

Contractor:  
Thomas Myer  
Phone: (509)373-3126  
Email: Thomas_G_Myer@rl.gov

ORP:  
Jeffrey Rambo  
Phone: (509)376-4997  
Email: Jeffrey_J_Rambo@orp.doe.gov
RISK INFORMED TANK RETRIEVAL STRATEGY

TEDS ID: RTW-39  Priority: High  Rank: 12

TECHNOLOGY NEED

A volume-based retrieval standard has been used as defined in the Tri-Party Agreement and Consent Decree. 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

Develop a risk-informed set of retrieval requirements to replace the current volume-based retrieval requirement. This strategy is expected to 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 existing Tri-Party Agreement volume-based retrieval approach.
- Identify incremental sampling analysis for WMA A-AX tanks that could better inform this retrieval strategy.

RISKS AND OPPORTUNITIES

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

Contractor: Thomas Myer  Phone: (509)373-3126  Email: Thomas_G_Myer@rl.gov
ORP: Jeffrey Rambo  Phone: (509)376-4997  Email: Jeffrey_J_Rambo@orp.doe.gov
THREE-DIMENSIONAL FLASH LIDAR TO MAP WASTE TANKS

TEDS ID: RTW-53  Priority: High  Rank: 29

TECHNOLOGY NEED

Current methods to measure volumes of residual solids left in the tanks are estimations based on analysis of a series of photographs taken as the residual material dries. This approach is typically labor intensive, time-consuming (dependent on the drying period), and prone to uncertainties associated with interpretation of features captured in the photographs.

TECHNOLOGY SOLUTION

Testing of the light detection and ranging (LIDAR) system and stitching software with various simulated wastes to determine if it can map contours under water and any other limitations would then need to occur. The system is planned to be demonstrated to ensure it is viable in the Hanford Site tank environment. The proposed mapping technology offers the potential of reducing the required labor, reducing the task duration (no waiting for waste to dry), improving mapping accuracy (more quantitative data), and mapping solids under water.

RISKS AND OPPORTUNITIES

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes
<table>
<thead>
<tr>
<th>TEDS ID: RTW-54</th>
<th>Priority: High</th>
<th>Rank: 9</th>
</tr>
</thead>
</table>

**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.

---

**Contractor:** Kayle Boomer  
Phone: (509)372-3629  
Email: Kayle_D_Boomer@rl.gov

**ORP:** Kaylin Burnett  
Phone: (509)372-0622  
Email: Kaylin_W_Burnett@orp.doe.gov

---

**RISKS AND OPPORTUNITIES**

OPP-004, Alternate Supplemental Treatment Technology Development Results in an Acceptable Process That Improves Cost and/or Schedule Performance Against the Assumed Baseline

---

Technology Maturation Level: Modify Existing Technology
National Laboratory Involvement? Yes
Submitted as Grand Challenge? Yes
Rough Order of Magnitude Cost? <$1 Million
TECHNOLOGY TO SUPPORT RISK-BASED RETRIEVAL AND CLOSURE

TEDS ID: RTW-56  Priority: High  Rank: 11

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.

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

RPP-007, SST Retrieval Volume is Greater Than Planned.

Contractor:  Kirk Cantrell  
Phone:  (509)372-6362  
Email:  Kirk.Cantrell@pnnl.gov

ORP:  Elaine Diaz  
Phone:  (509)373-9757  
Email:  Elaine_N_Diaz@orp.doe.gov
REMOTE TANK FARM ABOVE GROUND INSPECTIONS

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.

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.

RISKS AND OPPORTUNITIES

A/AX-77, Tank Vapors Result in Unanticipated Work Stoppages

Contractor: Thomas Myer
Phone: (509)373-3126
Email: Thomas_G_Myer@rl.gov

ORP: Jeffrey Rambo
Phone: (509)376-4997
Email: Jeffrey_J_Rambo@orp.doe.gov
This review is needed to identify areas where new information or technology maturation can provide the greatest future benefit (e.g., altered retrieval requirements, affected closure cap design). Information is then planned for integration into Rev. 1 of the WMA C PA and into the assessments being developed for other waste management area closures.

TECHNOLOGY NEED

This technology is needed to support future update of the Waste Management Area (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.

RISKS AND OPPORTUNITIES

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

Contractor: Steve Kelly
Phone: (509)376-0717
Email: Steven_E_Kelly@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
DEVELOPMENT OF PORTABLE GAMMA RADIATION MONITORING SYSTEM

TEDS ID: RTW-11  Priority: Medium  Rank: N/A

TECHNOLOGY NEED

Gamma scanning in the drywells adjacent to the underground storage tanks containing high radiation waste is required to monitor for leaks before and after retrieval activities. Additionally, leaking or suspected leaking waste tanks may require additional scanning. The project needs a portable gamma scanner in support of scanning drywells. The portable unit can be used when access to the drywells is not available for the existing gamma scanning truck.

TECHNOLOGY SOLUTION

Procure, engineer, and test a portable gamma scanning instrument system that facilitates incremental scanning of the entire depth of each drywell.

New Mobile Gamma Scanner with Standard Length Cable

RISKS AND OPPORTUNITIES

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

Contractor: Thomas Myer  Phone: (509)373-3126  Email: Thomas_G_Myer@rl.gov
ORP: Jeffrey Rambo  Phone: (509)376-4997  Email: Jeffrey_J_Rambo@orp.doe.gov
IMPROVED SOLUBILITY MODELING OF ALUMINUM

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.

RISKS AND OPPORTUNITIES

RPP-040, IHLW Glass Mass Differs from Plan

Contractor: Michael Britton  Phone: (509)376-6639  Email: michael_D_britton@rl.gov

ORP: Elaine Diaz  Phone: (509)373-9757  Email: Elaine_N_Diaz@orp.doe.gov
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.

**TECHNOLOGY SOLUTION**

Fluoride Solubility Data

**RISKS AND OPPORTUNITIES**

RPP-040, IHLW Glass Mass Differs from Plan

**Contractor:** Michael Britton  
Phone: (509)376-6639  
Email: Michael_D_Britton@rl.gov

**ORP:** Elaine Diaz  
Phone: (509)373-9757  
Email: Elaine_N_Diaz@orp.doe.gov
IMPROVED SOLUBILITY MODELING OF PHOSPHATE

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

TECHNOLOGY NEED

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

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

RPP-040, IHLW Glass Mass Differs from Plan

Contractor: Michael Britton  
Phone: (509)376-6639  
Email: Michael_D_Britton@rl.gov

ORP: Elaine Diaz  
Phone: (509)373-9757  
Email: Elaine_N_Diaz@orp.doe.gov
Development of the technology to deliver neutron poisons have the potential to provide a criticality safety control strategy for waste retrieval 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 standard ANSI/ANS-8, Fissionable Material Outside Reactors, on soluble poison additions are also planned to be addressed as required under DOE O 420.1C, Facility Safety.

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

Risks and Opportunities

- RPP-019, CH-TRU Waste Treatment Throughput LTA
- RPP-033, WTP PT Throughput Rate Does Not Meet Plan
- RPP-039, WTP HLW Throughput Rate Does Not Meet Plan

Contractor: Joseph Meacham
Phone: (509)373-1961
Email: Joseph_E_Meacham@rl.gov

ORP: Joseph Christensen
Phone: (509)376-5863
Email: Joseph_A_Christensen@orp.doe.gov
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.

To date, the 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.

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.

RPP-006, SST Retrieval System Performance Does Not Meet Requirements Due to Controllable Causes
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 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 can 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 consists of four subtasks:

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 NEMA-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**

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

**Contractor:** Marcel Bergeon  
**Tele:** (509)376-4924  
**Email:** Marcel_P_Bergeron@rl.gov

**ORP:** Elaine Diaz  
**Tele:** (509)373-9757  
**Email:** Elaine_N_Diaz@orp.doe.gov
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 is expected to 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?**
$1-$5 Million

**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 DST solids inventory and freeing up space.

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.

**Risks and Opportunities**

N/A

**Contractor:** Kayle Boomer  
Phone: (509)372-3629  
Email: Kayle_D_Boomer@rl.gov

**ORP:** Jeffrey Rambo  
Phone: (509)376-4997  
Email: Jeffrey_J_Rambo@orp.doe.gov
HANFORD SITE
US DEPT OF ENERGY

NEEDED

Barrier technology is in the planning stage, requiring development from the “ground-up.” Completion of the scope within RTW-52 would produce a report that presents deployable barrier options to allow existing retrieval techniques for leaker-tanks.

Technology Maturation Level:
Research and Concept

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost?
< $1 Million

TEXTE 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.

RISKS AND OPPORTUNITIES

TFP-3 Funding Not Available When Required

Contractor: Don Parker
Phone: (509)372-0766
Email: Danny_L_Parker@rl.gov

ORP: Jeffrey Rambo
Phone: (509)376-4997
Email: Jeffrey_J_Rambo@orp.doe.gov
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.

Appendix H 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.

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 is planned. A down-selected technology can then be configured and deployed in coordination with the other soil characterizations.

RISKS AND OPPORTUNITIES

RPP-054, Facility Closure Costs Are Not Fully Evaluated
DEVELOPMENT TESTING OF HIGH-RADIATION HOSE MATERIALS

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 may compromise the hoses, considerably shortening their life expectancy.

Development and testing of high-radiation hose material has the potential to 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 likely includes testing to meet the physical requirements (e.g., pressure, flexibility, temperature) of the hoses. Based on successful testing, a prototype hose material is expected to be designed, fabricated, and delivered to the Hanford Site for final testing and deployment.

RISKS AND OPPORTUNITIES

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

Contractor: Thomas Myer  Phone: (509)373-3126  Email: Thomas_G_Myer@rl.gov

ORP: Jeffrey Rambo  Phone: (509)376-4997  Email: Jeffrey_J_Rambo@orp.doe.gov
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.

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.

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.

Risks and Opportunities

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

Contractor: Steve Kelly
Phone: (509)376-0717
Email: Steven_E_Kelly@rl.gov

ORP: Gary Olsen
Phone: (509)376-0670
Email: Gary_B_Olsen@orp.doe.gov
An integrated feed qualification program has the ability to identify 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?
<$1 Million

DEVELOP AN INTEGRATED HLW FEED QUALIFICATION PLAN

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 TOC feed qualification program patterned after the operational program implemented at the Defense Waste Processing Facility. This program is expected to identify technology gaps and needs that can then be evaluated for the preferred path forward.

Sampling Qualification Test Loop

RISKS AND OPPORTUNITIES

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

Contractor:  Steve Kelly  Phone:  (509)376-0717  Email:  Steven_E_Kelly@rl.gov
ORP:  Gary Olsen  Phone:  (509)376-0670  Email:  Gary_B_Olsen@orp.doe.gov
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 is planned to be developed that considers the value and use of small-scale testing as a predecessor to full-scale testing. Note that the test facility may be available/capable of supporting other technology development needs. Work is planned to include reviewing mixer pump test results performed for Savannah River Site and Hanford Site tanks.

RISKS AND OPPORTUNITIES

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

Contractor: Steve Kelly  Phone: (509)376-0717  Email: Steven_E_Kelly@rl.gov

ORP: Dustin Stewart  Phone: (509)376-8950  Email: Dustin_M_Stewart@orp.doe.gov
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 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 waste.

This twofold approach should result in less heat input. The modeling is expected to be similar to previous thermodynamic modeling of DST systems. The mixer pump configuration testing is planned to utilize small-scale testing to demonstrate mixing effectiveness, and the mixing text can then be combined with thermodynamic modeling to estimate the overall heat balance.

**Risks and Opportunities**

RPP-011, DSTs Not Ready to Perform Mission Functions

Contractor: **Steve Kelly**  
Phone: (509)376-0717  
Email: Steven_E_Kelly@rl.gov

ORP: **Dustin Stewart**  
Phone: (509)376-8950  
Email: Dustin_M_Stewart@orp.doe.gov
TRU/SR-90 PRECIPITATION IN DOUBLE-SHELL TANKS

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 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 development approach is twofold:

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 is expected to include review and incorporation of lessons learned from monosodium titanite strikes at the Savannah River Site.

RISKS AND OPPORTUNITIES

RPP-033, WTP PT Throughput LTA

Contractor: Jacob Reynolds
Phone: (509)373-5999
Email: Jacob_G_Reynolds@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
TECHNOLOGY NEED

The ESP modeling results are routinely used to inform process decision making. 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 custom databases may be necessary for these species. Also, systems of Na-NO3-NO2 and Na-F-PO4 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, shall be commissioned to investigate and develop needed customization of the ESP database.

RISKS AND OPPORTUNITIES

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate.
WASTE TRANSFER PIPE UNPLUGGING

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.

RISKS AND OPPORTUNITIES

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate
RPP-016, Cross-Site Transfer System is Not Available Upon Demand

Contractor: Ruben Mendoza
Phone: (509)373-7595
Email: Ruben_E_Mendoza@rl.gov

ORP: Jeremy Johnson
Phone: (509)376-1866
Email: Jeremy_M_Johnson@orp.doe.gov
A waste feed delivery strategy is needed that includes sampling and detection of plutonium particles that addresses potential criticality concerns.

TECHNOLOGY NEED

The One System report (RPP-RPT-56983/24590-WTP-RPT-MGT-14-022) identifies a potential waste feed delivery strategy to the WTP Pretreatment Facility, which relies on limiting the maximum amount of plutonium particulates (due to potential criticality concerns). Implementing a strategy to mitigate criticality concerns requires the ability to sample for and detect plutonium particulates in the waste feed tanks. The tank farms do not currently have the capability to sample for plutonium particulates with the accuracy that compliance with a waste acceptance limit would require.

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 at small-scale to determine which technology should be tested at larger scale. Perform pilot-scale testing of this technology, followed by qualification testing at full-scale to validate that the technology meets the performance requirements.

RISKS AND OPPORTUNITIES

RPP-013, Waste Feed Delivery is Not Available at the Demand Rate
RPP-019, CH-TRU Waste Treatment Throughput LTA

Contractor: Douglas Hendrickson
Phone: (509)373-1601
Email: Douglas_W_Hendrickson@rl.gov

ORP: Dustin Stewart
Phone: (509)376-8950
Email: Dustin_M_Stewart@orp.doe.gov
**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 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.

**RISKS AND OPPORTUNITIES**

RPP-019, CH-TRU Waste Treatment Throughput LTA

<table>
<thead>
<tr>
<th>Contractor:</th>
<th>David Losey</th>
<th>ORP:</th>
<th>Joseph Christensen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone:</td>
<td>(509)373-7700</td>
<td>Phone:</td>
<td>(509)376-5863</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:David_C_Losey@rl.gov">David_C_Losey@rl.gov</a></td>
<td>Email:</td>
<td><a href="mailto:Joseph_A_Christensen@orp.doe.gov">Joseph_A_Christensen@orp.doe.gov</a></td>
</tr>
</tbody>
</table>
4.3 Process Tank Waste

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 HLW fractions at the WTP Pretreatment Facility. Some of the LAW will be vitrified into borosilicate glass at the WTP LAW Facility. The HLW fraction of the waste will be vitrified into borosilicate glass at the WTP HLW Facility. The WTP LAW 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 always envisioned to treat part of the LAW (ORP-11242, River Protection Project System Plan). 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. The decision will be made after the startup of DFLAW. Additional supplemental treatment technology elements will be added after that decision is made.

The TOC is committed to providing support for startup of the WTP LAW Facility by designing and deploying the DFLAW pretreatment facilities, which may enable early facility startup.

As the RPP mission transitions from managing and retrieving tank farms to waste treatment operations by the WTP, 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 support DFLAW.

The PTW function includes the following focus areas:

1. DFLAW Pretreatment Operations — Uses ion-exchange (IX) filtration to remove suspended solids containing alpha-emitting TRU nuclides and highly radioactive strontium-90, and IX filtration 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 WTP LAW 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 from the off-gas treatment system.

4. WTP HLW — The HLW 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.
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 4.3.1 and 4.3.2 include the catalog sheets for the technologies that fall under the PTW function.
4.3.1 PTW Catalog Sheets – Planned

**RANKED HIGH**
PTW-52  DFLAW Pretreatment Operations Technology Maturation.......................... 4-94

**RANKED MEDIUM**
PTW-23  WTP EMF Bottoms Waste Stream Management Technologies .................. 4-96
PTW-24  Advanced Dynamic Simulation Modeling Platform .................................. 4-98
PTW-28  Operations Productivity and Analysis Tools ............................................. 4-100
PTW-38  Radioactive Waste Test Platform .............................................................. 4-102
PTW-39  Virtual Workbench for Waste Processing .................................................. 4-104
This page intentionally left blank.
TECHNOLOGY NEED

Integrated scale testing supports the Low-Activity Waste Pretreatment System (LAWPS)/Tank-Side Cesium Removal (TSCR) project schedule to achieve a Technology Readiness Level (TRL) 6 for the critical technology elements before the end of Critical Decision 2 (CD-2) consistent with guidance provided in the DOE Office of Environmental Management Technology Readiness Assessment (TRA)/Technology Maturation Plan (TMP) Process Implementation Guide (DOE-EM 2013).

TECHNOLOGY SOLUTION

- Perform integrated testing of the filtration and ion exchange technologies at a 1/9 scale.
- Perform bench-scale support test to determine gas generation (hydrogen) rate with ion exchange media under planned processing conditions as needed.
- Perform bench-scale support test to determine the drying rate for ion exchange media under planned processing conditions as needed.
- Perform bench-scale support test for filtration under planned processing conditions as needed.
- Perform tall column testing for prototypic process conditions.
- Perform batch equilibrium testing for a range of Hanford-specific conditions.
ADDITIONAL TECHNICAL INFORMATION

The LAWPS/TSCR project is in the process of a redesign to align with using a non-elutable ion exchange system and a dead end filter. These changes are a result of an independent team review documented in the LAWPS external review report (RPP-RPT-60405) and direction from the DOE Office of River Protection. It should also be noted that due to similarities between TSCR and LAWPS; the technology maturation approach has been coordinated to allow both projects to benefit from the testing data obtained and to help eliminate duplication of effort.

Note: This PTW-52 replaces PTW-17, PTW-18, and PTW-19, combing the remaining work from those three technology development activities.

COST AND SCHEDULE SUMMARY

WBS numbers: 5.05.24.02.02.01 and 5.05.24.02.01.03

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th></th>
<th>FY19</th>
<th></th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
</tr>
<tr>
<td>Integrated testing of the filtration and IX technologies at a 1/9 scale</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bench-Scale Support Tests for gas generation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bench-Scale Support Tests for IX media drying</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bench-Scale Support Tests for filtration</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tall Column Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>IX Batch Equilibrium Tests</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1,044</td>
<td>$3,076</td>
<td>$4,120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-024, LAWPS Hot Commissioning is Delayed

Contractor Contact: Matt Landon
Phone: (509)373-1379
Email: Matthew_R_landon@rl.gov

DOE ORP Contact: Janet Diediker
Phone: (509)372-3043
Email: Janet_A_Diediker@orp.doe.gov
TECHNOLOGY NEED

Technical assessments have determined that there is an opportunity to provide a low-cost, low-technical risk activity that has potential to save ~$5 billion in supplemental immobilization lifecycle costs; enable a major reduction in dominant Hanford Site Integrated Disposal Facility (IDF) Performance Assessment (PA) (RPP-RPT-59958) groundwater risk; and remove the key radionuclide driver for a ‘good as glass’ waste form. Since the technetium-99 (Tc-99) is planned to be immobilized as low-activity waste (LAW), and some fraction as secondary waste, it can remain onsite at the IDF rather than be shipped away to a geologic repository. As Tc-99 has a very long half-life, it will likely be a major dose contributor to the IDF PA.

TECHNOLOGY SOLUTION

There are multiple projects targeting this approach:

1. Develop a non-glass waste form for the Waste Treatment and Immobilization Plant (WTP) Effluent Management Facility (EMF) bottoms waste stream for alternative disposition path(s).
2. Develop non-glass waste form for the bulk chemistry of EMF bottoms waste stream.
3. Remove Tc from EMF bottom waste stream and scoping for low temperature glass suitable for IDF disposal.
4. Investigate the complete chemical composition of the WTP off-gas waste stream, technetium retention in glass and Tc partitioning in melter system (Vitreous State Laboratory).

Non-Glass Waste Form Bulk Density
**ADDITIONAL TECHNICAL INFORMATION**

Due to its soluble nature and potential volatility during high temperature treatment processes (e.g., vitrification) effective Tc management is important to the success of the overall River Protection Project mission. Removal of Tc from the LAW would eliminate a key risk driver for the IDF PA. Removal of Tc-99 from the LAW vitrification off-gas condensate stream would enable alternate disposition of this stream to eliminate its return to the double-shell tanks or recycle to LAW vitrification feed.

**COST AND SCHEDULE SUMMARY**

<table>
<thead>
<tr>
<th>WBS number: 5.03.12.02.03</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td>Investigating chemical composition of WTP off-gas waste stream, COC retention in glass and COC partitioning in melter system</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Immobilization of EMF bottoms waste stream</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Removal of Tc from EMF bottoms waste stream</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Low temperature glass for EMF bottoms COCs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$2,500</td>
<td>$1,500</td>
<td>$1,500</td>
<td>$5,500</td>
</tr>
</tbody>
</table>

**RISKS AND OPPORTUNITIES**

RPP-031, WTP EMF Product Outputs do not meet the Required Facility WACs (TF DST, WTP LAW, LERF/ETF)

**Contractor Contact:** Ridha Mabrouski  
Phone: (509)373-2158  
Email: Ridha_B_Mabrouski@rl.gov

**DOE ORP Contact:** Kaylin Burnett  
Phone: (509)372-0622  
Email: Kaylin_W_Burnett@orp.doe.gov
### TECHNOLOGY NEED

One System charter, and in particular its mission analysis, requires modeling analysis to support operational planning, including the 5-year operating plan, mission analysis report, double-shell tank space plan, retrieval plan, and waste feed delivery plan. A recent independent management assessment report (FY2015-OS-M-0131) concluded that the deficiencies of the current G2-based system represent short-term challenges and long-term risks to the organization and that it likely needs to be replaced within 5 to 7 years.

### TECHNOLOGY SOLUTION

Development of a near-term operations tool (to simulate near-term tank farm waste transfer activities) was initiated in FY 2017 and is being managed and executed by the One System Mission Analysis organization. Development of the near-term operations tool is anticipated to extend through the end of FY 2018. Preliminary requirements development for the long-term planning tool started in FY 2018.
RPP PLAN 43988, Rev. 4

ADDITIONAL TECHNICAL INFORMATION

Input Screen for the Near-Term Operations Tool

COST AND SCHEDULE SUMMARY

WBS number: 5.3.1.2.7.11

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18 Q1</th>
<th>FY18 Q2</th>
<th>FY18 Q3</th>
<th>FY18 Q4</th>
<th>FY20 Q1</th>
<th>FY20 Q2</th>
<th>FY20 Q3</th>
<th>FY20 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 (Near-Term Operations Tool)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$730</td>
</tr>
<tr>
<td>Phase 2 (Long-Term Cost/Risk/OR Tool)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$2,730</td>
</tr>
</tbody>
</table>

Funding in thousands (000s)

<table>
<thead>
<tr>
<th></th>
<th>FY18</th>
<th>FY18</th>
<th>FY20</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
<td>$730</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$2,730</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-063, Estimate Uncertainty

Contractor Contact: Jeremy Belsher  
Phone: (509)376-2372  
Email: Jeremy_D_Belsher@rl.gov

DOE ORP Contact: Kaylin Burnett  
Phone: (509)372-0622  
Email: Kaylin_W_Burnett@orp.doe.gov

TEDS ID: PTW-24 Continued
TECHNOLOGY NEED

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

1. Operations tracking tools – Gather the status of completed and non-completed.
2. Maintenance work package and round sheets – Allow filtering by Operations team.
3. Electronic turnover – Provides shift personnel a web platform to document the plant status at shift turnover.

TECHNOLOGY SOLUTION

The strategy is to provide TOC operations with tools to improve the status control and quality of communications and reduce the time required to determine the status of the facility. Examples of the tools being employed 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.
ADDITIONAL TECHNICAL INFORMATION

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.

Electronic rounds: Provides operators hand-held data collection devices, which eliminates data transcription errors and provides instant feedback for out of specification readings.

System deviation: Shows all active temporary modifications, bypasses, and logbook instructions.

Survey maps: Provide the ability to display and update electronic radiological maps for each tank farm.

COST AND SCHEDULE SUMMARY

WBS numbers: 5.1.1.13.25, 5.1.1.13.27, and 5.1.1.13.28

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18 Q1</th>
<th>FY18 Q2</th>
<th>FY18 Q3</th>
<th>FY18 Q4</th>
<th>FY19 Q1</th>
<th>FY19 Q2</th>
<th>FY19 Q3</th>
<th>FY19 Q4</th>
<th>FY20 Q1</th>
<th>FY20 Q2</th>
<th>FY20 Q3</th>
<th>FY20 Q4</th>
<th>FY21 Q1</th>
<th>FY21 Q2</th>
<th>FY21 Q3</th>
<th>FY21 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group#1 Operations Products</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td>Group#2 IH and Operations Products</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>$2,000</td>
<td></td>
</tr>
<tr>
<td>Group#3 RadCon, IH and Operations Products</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>$1,875</td>
<td></td>
</tr>
<tr>
<td>Group#4 Eng., RadCon, IH and Operations Products</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$1,500</td>
<td>$1,500</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
<td>$7,000</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-063, Estimate Uncertainty

Contractor Contact: Mirwaise Aurah  
Phone: (509)373-5786  
Email: Mirwaise_Aurah@rl.gov

DOE ORP Contact: Ellen Mattlin  
Phone: (509)376-1900  
Email: Ellen_m_mattlin@orp.doe.gov
RADIOACTIVE WASTE TEST PLATFORM

TEDS ID: PTW-38  
Priority: Medium  
Rank: N/A

TECHNOLOGY NEED


TECHNOLOGY SOLUTION

Based on current data needs for waste feed delivery and resolving flowsheet gaps a scaled test platform is needed and can be developed through completion of the following tasks:

- Task 1: Develop bench-scale unit operations.
- Task 2: Perform simulant testing.
- Task 3: Perform tank sampling of large quantities of waste.
- Task 4: Run platform using real waste, perform analysis collect data, report findings.

Process Flow Diagram for the Radioactive Waste Test Platform
ADDITIONAL TECHNICAL INFORMATION

![Hot Cell](image1)

![Melter](image2)

![Units Unit Filter](image3)

COST AND SCHEDULE SUMMARY

WBS numbers: 5.3.1.7.5.9 and 5.3.12.2.6.2

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 2 Perform Simulant Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Task 3 Perform tank sampling of large quantities of waste</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Task 4 Run Platform using real waste, perform analysis collect data, report findings</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$4,000</td>
<td>$4,000</td>
<td>$2,000</td>
<td>$8,000</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-026, LAWPS Throughput Rate Does Not Meet Plan

**Contractor Contact:** Kris Colosi  
Phone: (509)372-3395  
Email: Kristin_A_Colosi@rl.gov

**DOE ORP Contact:** Kaylin Burnett  
Phone: (509)372-0622  
Email: Kaylin_W_Burnett@orp.doe.gov
VIRTUAL WORKBENCH FOR WASTE PROCESSING

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

TECHNOLOGY NEED

An economical or innovative method to move waste tank slurry from the more remote SSTs is needed that can operate under today’s nuclear safety rules. A sampling and waste acceptance strategy that would simplify the Waste Treatment and Immobilization Plant design strategy without significantly impacting throughput or mission life is also needed.

TECHNOLOGY SOLUTION

The stages of the proposed virtual workbench (VWB) are described below along with their associated technical risk:

- **Stage 1, Integration of Existing Software into Akuna workflow:** Leveraging Akuna 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 TOPSim® involves technical risk, but careful planning (developing requirements and software design documents) is expected to mitigate this. Software development is planned to be completed in 5 years, before Waste Treatment and Immobilization Plant operations. Joint development with Savannah River Site contractors has the ability to decrease overall cost by sharing common elements.

- **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. Although this is technically challenging, development of new software may need to be supported by experimental work that provides a link to model input parameters and assumptions.
ADDITIONAL TECHNICAL INFORMATION

- Completeness of Option: In the first stage, the VWB framework is planned for completion. This is intended to provide an infrastructure to add capability to the VWB, as described in Stages 2 and 3.
- Ability to Execute within DOE Orders/Regulations: All software components require ASME NQA-1 qualification. The VWB is planned to be tested and documented to meet NQA-1 quality requirements.
- Regulatory Considerations: ASME NQA-1 software qualification is currently the only regulatory constraint. Moreover, the framework gives regulators access to all tools and analyses.

COST AND SCHEDULE SUMMARY

WBS numbers: TBD

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY19 Q1</th>
<th>FY19 Q2</th>
<th>FY19 Q3</th>
<th>FY19 Q4</th>
<th>FY20 Q1</th>
<th>FY20 Q2</th>
<th>FY20 Q3</th>
<th>FY20 Q4</th>
<th>FY21 Q1</th>
<th>FY21 Q2</th>
<th>FY21 Q3</th>
<th>FY21 Q4</th>
<th>FY22 Q1</th>
<th>FY22 Q2</th>
<th>FY22 Q3</th>
<th>FY22 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1. Integration of Existing Software into ASCEM Workflow:s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2. Core Software Replacement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3. Develop New Components for the VWB:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$2,000</td>
<td>$3,000</td>
<td>$4,000</td>
<td>$4,000</td>
<td>$13,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-028, LAWPS Secondary Solid Waste Disposal Not as Planned

Contractor Contact: Jason Vitali  
Phone: (509)376-6751  
Email: Jason_R_Vitali@rl.gov

DOE ORP Contact: Billie Mauss  
Phone: (509)373-5133  
Email: Billie_M_Mauss@orp.doe.gov
4.3.2 PTW Catalog Sheets – Needed

**RANKED HIGH**
- PTW-40 High-Level Waste Phased Approach .......................................................... 4-107
- PTW-48 Prevention of Hydrogen Gas Buildup ......................................................... 4-108
- PTW-49 Feasibility of Removing Nitrates from the LAW Feed .......................... 4-109
- PTW-51 Nitrite-Hydroxide Solubility to Determine Aluminum Solubility in DFLAW ......................................................................................................................... 4-110

**RANKED MEDIUM**
- PTW-26 Operations Productivity and Analysis Tools ............................................. 4-111
- PTW-42 High-Level Waste Condensate Treatment .............................................. 4-112
- PTW-45 Operations Productivity and Analysis Tools ............................................. 4-113
- PTW-46 Advance CH-TRU Tank Waste Treatment Technologies .................. 4-114
- PTW-50 High-Level Waste Solids Segregation ....................................................... 4-115

**RANKED LOW**
- PTW-41 Methods to Safely Remove, Store and Dispose of Cesium ..................... 4-116
- PTW-43 Multiple Cycle Testing of sRF Resin in a Radiation Field ....................... 4-117
The current DOE Letter of Direction calls for a phased approach to the startup of River Protection Project facilities and activities. The proposed high-level waste phased approach builds off of the current DOE strategy by enabling processing high-level waste solids in the absence of pretreatment.

**TECHNOLOGY NEED**

This proposal would be an opportunity to avoid or reduced costs associated with the mission. Direct-feed high-level waste (DFHLW) would less closely couple the Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste, High-Level Waste (HLW), and Pretreatment Facilities, enabling more process flexibility and enabling efficient use of facilities and earlier processing of HLW. This proposal is driven by the need to reduce the amount of glass produced, which in turn reduces the mission length and cost of the HLW glass management.

**TECHNOLOGY SOLUTION**

The following detailed engineering studies and program planning are necessary to facilitate the ultimate implementation of the strategy:

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

**RISKS AND OPPORTUNITIES**

RPP-033, WTP PT Throughput LTA

**Contractor:** Jason Vitali  
Phone: (509)376-6751  
Email: Jason_R_Vitali@rl.gov

**ORP:** Elaine Diaz  
Phone: (509)373-9757  
Email: Elaine_N_Diaz@orp.doe.gov
HANFORD SITE
US DEPT OF ENERGY

NEEDED

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

TECHNOLOGY NEED

There has been ongoing discussion around increasing the direct-feed low-activity waste pretreatment operations maximum sodium molarity beyond 6M; however, since hydrogen solubility decreases with increasing sodium molarity (as well as influence by other gasses e.g. nitrogen, nitrous oxide, and methane) and since the existing testing maxed out just over 6M, additional testing is needed at higher sodium molarities to support an increase in Low-Activity Waste Pretreatment System (LAWPS)/Tank-Site Cesium Removal (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

RPP-026, LAWPS Throughput Rate Does Not Meet Plan
RPP-039, WTP HLW Throughput Rate Does Not Meet Plan

Contractor: Rose Russell
Phone: (509)376-0451
Email: Rose_M_Russell@rl.gov

ORP: Sahid Smith
Phone: (509)376-5512
Email: Sahid.Smith@orp.doe.gov
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) 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 Facility, resulting in potentially no active safety functions within that facility.

This approach evaluates the 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.

Risks and Opportunities

OPP-004, Alternate Supplemental Treatment Technology Development
Results in an Acceptable Process That Improves Cost and/or Schedule Performance Against the Assumed Baseline

Contractor: Jason Vitali
Phone: (509)376-6751
Email: Jason_R_Vitali@rl.gov

ORP: Kaylin Burnett
Phone: (509)372-0622
Email: Kaylin_W_Burnett@orp.doe.gov
Conduct a study to determine if aluminum is expected to precipitate and foul the direct-feed low-activity waste process, solubility interaction factors are needed between all major constituents in the liquid phase with both the aluminate ion and nitrite ion. The nitrite-hydroxide interaction factor is currently missing.

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 it 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, three to four data points are needed over the whole solubility range at least four different temperatures.

RISKS AND OPPORTUNITIES

N/A

Contractor: Jacob Reynolds
Phone: (509)373-5999
Email: Jacob_G_Reynolds@rl.gov

ORP: Elaine Diaz
Phone: (509)373-9757
Email: Elaine_N_Diaz@orp.doe.gov
TECHNOLOGY SOLUTION

Developing a consolidated high-fidelity operator training simulator (OTS) would provide:

1. Increased situational awareness and status control.
2. Improved response times for upset conditions.
3. Improved operator environment.
4. Reduced operating cost.
5. Encouraged excellent and predictable conduct of operations.
6. Reduced unnecessary ‘process runs’ operations due to training.
7. Help to refine procedures and establish robust response process.

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

• Prevention cheaper than cure.
• Prevention by preparation.

RISKS AND OPPORTUNITIES

RPP-063, Estimate Uncertainty

Contractor: Mirwaise Aurah
Phone: (509)373-5786
Email: Mirwaise_Aurah@rl.gov

ORP: Jeffrey Rambo
Phone: (509)376-4997
Email: Jeffery_J_Rambo@orp.doe.gov
HIGH-LEVEL WASTE CONDENSATE TREATMENT

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

TECHNOLOGY NEED

Current River Protection Project system models (Hanford Tank Waste Operations Simulator and Dynamic Flowsheet Model [G2]) show the Waste Treatment and Immobilization Plant (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 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.

RISKS AND OPPORTUNITIES

RPP-039, WTP HLW Throughput Rate Does Not Meet Plan

Contractor: Jason Vitali  Phone: (509)376-6751  Email: Jason_R_Vitali@rl.gov
ORP: Elaine Diaz  Phone: (509)373-9757  Email: Elaine_N_Diaz@orp.doe.gov
The overall goal of this project is to demonstrate a novel method of selectively sequestering the pertechnetate (Tc (VII)) ion (TcO4-) from radioactive liquid waste by absorbing the watersoluble Tc-99 isotope into porous organic frameworks or porous aromatic frameworks with appropriate functional groups.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
No

Submitted as Grand Challenge?
No

Rough Order of Magnitude Cost?
$1-$5 Million

TECHNOLOGY NEED

The efficient capture and immobilization of technetium-99 (Tc-99) is a risk to the Hanford mission because possible contamination levels in ground water are proportional to ~26,500 Ci of Tc-99 currently stored in 177 tanks. Process flow sheets indicate that almost all (i.e., >90%) Tc-99 is likely present in the liquid low-activity waste (LAW) being sent to the LAW melter for processing. However, a significant fraction of the Tc-99 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 Tc-99 from the liquid secondary waste from LAW melter off-gas condensate is needed to address this issue. In addition, a viable option is needed to immobilize sorbent loaded with Tc-99 into a stable waste form.

TECHNOLOGY SOLUTION

The objective of this project is to develop and demonstrate a new class of porous aromatic frameworks that has a high sorption capacity and selectivity for the TcO4- from liquid waste and can be subsequently stabilized in a low-cost cementitious waste form. The goals are as follows: z

1. Synthesize aqueous stable PAF with high density of quaternary ammonium salts.
2. Evaluate the TcO4- selectivity over other competing anions with batch experiments.
3. Develop and evaluate stabilization of the technetium-laden porous aromatic frameworks in low-cost cementitious waste form.
4. Demonstrate the selectivity and sorption kinetics TcO4- from liquid LAW under realistic conditions.

RISKS AND OPPORTUNITIES

N/A

Contractor: Dave Swanberg
Phone: (509)373-5786
Email: David_J_Swanberg@rl.gov

ORP: Albert Kruger
Phone: (509)376-4997
Email: Albert_A_Kruger@orp.doe.gov
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?
$5-$10 Million

Technology Solution
The existing dryer technology needs re-evaluation, in concert with retrieval strategy. A typical mechanical treatment system is shown in the figure below. The WRPS Engineering organization is initiated 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 the 2014 study.

Risks and Opportunities
RPP-019, CH-TRU Waste Treatment Throughput LTA

Contractor: Allan (Rick) Tedeschi
Phone: (509)373-6108
Email: Allan_R_Rick_Tedeschi@rl.gov

ORP: Kaylin Burnett
Phone: (509)372-0622
Email: Kaylin_W_Burnett@orp.doe.gov
Hydrocyclones are the most widely used classifiers in a wet grinding circuit due to their relative efficiency if designed correctly, high throughput, smaller size and lower cost, and their simplicity, as they contain no moving parts. Hydrocyclones are able to separate particles from slurry over a fairly large range of sizes (i.e., 5 to 500 microns). The slurry stream is fed tangentially into the cone shaped hydrocyclone which forces the slurry to rotate. This causes centrifugal forces within the stream accelerating the settling rate of the particles forcing the denser/larger particles to settle to the bottom of the cone, underflow, with the less dense/smaller particles exiting the top of the cone, overflow. The underflow is cycled back into the grinding circuit and the overflow is moved forward for processing. There is considerable amount of literature. This literature is based Newtonian fluids; therefore development work may be needed to verify performance with non-Newtonian or other slower settling slurries.

TECHNOLOGY NEED

Protect feed delivery system by providing particle size-density criteria for pretreatment; and presort to protect ultrafilters. Reduce risks by serving to protect Pretreatment (PT) Facility equipment. The approach would be to use the technology for size sorting of waste in the tank farms to ensure appropriate sizing for feed to High-Level Waste Facility (direct) versus PT Facility direct or to ensure high-level waste particle size meets the PT Facility waste acceptance when PT is used.

RISKS AND OPPORTUNITIES

N/A

Contractor: Jason Vitali
Phone: (509)376-6751
Email: Jason_R_Vitali@rl.gov

ORP: Don Alexander
Phone: (509)373-3731
Email: Don_H_Alexander@rl.gov
Cesium removal and interim storage cesium-containing resin supports direct-feed low-activity waste immobilization. Methods are needed to safely remove, store, and dispose of cesium using a modular, skid-based ion exchange system to allow treatment of the decontaminated low-activity waste.

TECHNOLOGY NEED

Per the low-level waste classification criteria in 10 CFR 61.55, the maximum allowable cesium-137 concentrations for Class A, B, and C low-level waste is 1, 44, and 4600 Ci/m³, respectively. Given that there is approximately 75 MCi of cesium currently in the Hanford Site tank farms, there is a need to develop an alternative approach to safely store and dispose of cesium-contaminated waste.

TECHNOLOGY SOLUTION

Evaluate alternatives for cesium removal (ion exchange media and system configuration), interim storage (for high-level waste and low-activity waste), and final disposition (onsite vitrification, offsite disposal).

RISKS AND OPPORTUNITIES

RPP-027, LAWPS Product Output Does Not Meet the Design Expectations of WTP LAW WAC

Contractor: Jason Vitali
Phone: (509)376-6751
Email: Jason_R_Vitali@rl.gov

ORP: Elaine Diaz
Phone: (509)373-9757
Email: Elaine_N_Diaz@orp.doe.gov

Technology Maturation Level.
Research and Concept

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
Yes

Rough Order of Magnitude Cost?
<$1 Million
# TECHNOLOGY NEED

The maximum number of cycles that a column of sRF (spherical resorcinol formaldehyde) resin has been run is six. There was also a test where the resin was cycled two times using actual tank waste. The current baseline for the Low-Activity Waste Pretreatment System is to use the sRF resin for 30 cycles while the Waste Treatment and Immobilization Plant baseline is 10 cycles. Since cost and availability of the sRF resin is a risk for the project, good information on the stability of the resin is important.

## TECHNOLOGY SOLUTION

Up to eight columns containing sRF resin would be cycled in a radiation field from 15 to 40 cycles. The irradiated resin would be examined for physical changes and changes in capacity over the length of the experiment to provide information on the longevity and functioning of the resin during operations. A set of cycles of the sRF resin using actual waste could be performed using a radioactive test bed currently under development though a DOE Headquarters program.

## RISKS AND OPPORTUNITIES

N/A
4.4 Dispose Tank Waste

Dispose 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. Secondary liquid waste effluents will be treated at the Effluent Treatment Facility (ETF) and disposed at a permitted land disposal site. ETF secondary solid waste will be disposed at the Integrated Disposal Facility (IDF). Immobilized LAW (ILAW) and 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 request for proposal was issued after initial TEDS identification. The Test Bed Initiative will be captured in Revision 5 of this Roadmap.

The DTW function includes the following focus areas:

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 CH2MILL 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 4.4.1 and 4.4.2 include the catalog sheets for the technologies that fall under the DTW function.
4.4.1 DTW Catalog Sheets – Planned

**RANKED HIGH**

DTW-03 Immobilized ILAW Glass Testing for IDF PA Support ........................................ 4-120
DTW-07 Solidification and Stabilization of Solid Secondary Waste ................................. 4-122

**RANKED MEDIUM**

DTW-01 Solidification and Stabilization of LSW from ETF ........................................... 4-124
DTW-02 Low Temperature Waste Form Process .............................................................. 4-126

**RANKED LOW**

DTW-08 IDF Long-Term Waste Form Durability Study (Lysimeter Data) ......................... 4-128
IMMOBILIZED ILAW GLASS TESTING FOR IDF PA SUPPORT

TEDS ID: DTW-03  Priority: High  Rank: 17

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 Facility, starting with direct-feed LAW (DFLAW) processing, is planned to 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 in order to permit and operate the IDF. Work performed in FY 2017 and FY 2018 supports improvements in waste loading/processing. Near-term risk to not performing these activities is having the IDF PA restrict higher (than baseline) waste loading glasses. Long-term risks are expected to impact the cost of operation for immobilized LAW and IDF due to opportunity loss in throughput and storage space, respectively.

TECHNOLOGY SOLUTION

The 2017 IDF PA performed analysis on baseline glasses. However, to improve the waste loading, a new glass model (enhanced model) is being developed with the aim on implementing immediately after DFLAW LAW Pretreatment System commissioning. To implement enhanced glass formulation, testing data is needed so that the results can support the PA maintenance that will likely be performed right before startup of DFLAW.

Technology Maturation Level.
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

ORLEC33 Glass
ADDITIONAL TECHNICAL INFORMATION

Immobilized LAW glass testing activities for FY 2018 are planned to be done on enhanced glasses. Testing involves SPFT (to determine the needed rate law parameters) PCT-B (to determine secondary phases) and Stage III zeolite analysis (to determine the possibility of accelerated acceleration in glass in the IDF conditions). The information is expected to be compiled in a data package to be used for the IDF PA maintenance.

COST AND SCHEDULE SUMMARY

WBS numbers: 55.3.6.1.4.2 and 5.3.6.1.4.3

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Glass Rate LAW/Durability (integrate with WTP WFQ)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass and Cement Waste Form Lysimeter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste Form Interactions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary Phase Reaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOC Oversight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>4,600</td>
<td>4,000</td>
<td>8,600</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-050, IDF Startup is Delayed, Affecting RPP Disposal Operations

Contractor Contact: **David Swanberg**  
Phone: (509)376-0710  
Email: David_J_Swanberg@rl.gov

DOE ORP Contact: **Gary Pyles**  
Phone: (509)376-2670  
Email: Gary.Pyles@orp.doe.gov
TECHNOLOGY NEED

During direct-feed low-activity waste (DFLAW) operations, radioactive solid secondary waste (SSW) is expected to 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, carbon absorption beds, iodine sorbent beds, and spent ion exchange resins. It is expected that 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). However, there has not been a development and testing program in place to collect data on Hanford Site SSW to be disposed in the IDF. Information available from published literature was reviewed, surveyed, and compiled in a data package for the 2017 IDF PA. Data and results of waste form development and testing of grouted Hanford Site SSW form are planned to 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, which indicated that there are four major SSW that can possibly have significant inventory of contaminants of concern when disposed in the IDF.
ADDITIONAL TECHNICAL INFORMATION

Four major SSWs – namely high-efficiency particulate air filters, carbon bed adsorbers, silver mordenite, and sRF (spherical resorcinol formaldehyde) resin – are anticipated to be the focus for the waste form development and testing until new information changes the priorities. Preliminary work has been completed on grouting sRF resin. Work is currently underway on carbon bed adsorber media, silver mordenite, and low-permeability grout for SSW encapsulation.

COST AND SCHEDULE SUMMARY

WBS number: 5.3.12.2.4

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
</tr>
<tr>
<td>Grout Formulation Development</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Leach Test of Encapsulation Grout</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Development and testing of WasteForm 1 (HEPA Filter)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Development and testing of WasteForm 2 (sRF Resin)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Development and testing of WasteForm 3 (Silver Mordenite)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Development and testing of WasteForm 4 (Carbon Bed Adsorber)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1000</td>
<td>$1500</td>
<td>$1500</td>
<td>$1000</td>
<td>$5000</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-028, LAWPS Secondary Solid Waste Disposal Not as Planned
RPP-034, WTP PT Radioactive Solid Waste Not Able to be Treated or Disposed of as Planned
RPP-037 WTP LAW Radioactive Solid Waste Not Able to be Treated or Disposed of as Planned
RPP-041, WTP HLW Radioactive Solid Waste Not Able to be Treated or Disposed of as Planned
RPP-047, Supplemental LAW Radioactive Solid Waste Not Able to be Treated or Disposed of as Planned

Contractor Contact:  Elvie Brown  
Phone: (509)376-7908  
Email: Elvie_Brown@rl.gov

DOE ORP Contact:  Gary Pyles  
Phone: (509)376-2670  
Email: Gary.Pyles@orp.doe.gov
SOLIDIFICATION AND STABILIZATION OF LSW FROM THE ETF

TEDS ID: DTW-01  Priority: Medium  Rank: N/A

TECHNOLOGY NEED

The River Protection Project is making preparations to start vitrification of Hanford low-activity waste (LAW) in the 2022 timeframe. LAW vitrification is planned to generate off-gas condensates that will be concentrated by evaporation at the Effluent Management Facility (EMF). EMF condensate must be processed through the Hanford Site Effluent Treatment Facility (ETF). The ETF secondary waste concentrate must be immobilized prior to disposal in the 200 Area Integrated Disposal Facility (IDF). Waste form performance data are needed to support maintenance of the IDF Performance Assessment (PA) (RPP-RPT-59958) to allow ultimate disposal of the waste form. Technology maturation activities are needed to demonstrate ETF secondary liquid waste waste form and treatment process are ready to be deployed.

TECHNOLOGY SOLUTION

The development/solution approach is described in a Technology Development Plan that is patterned after the DOE-G-413.1-4A technology maturation process and embodies a phased approach to mature the technology over multiple fiscal years.

Development of a cementitious waste form formulation for the solidification and stabilization of the liquid secondary wastes from the ETF.

Technology Maturation Level:
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Mixing of Cementitious Waste Form Components
SOLIDIFICATION AND STABILIZATION OF LSW FROM THE ETF

ADDITIONAL TECHNICAL INFORMATION

The logical progression of the technology development work includes waste form formulation development, testing to support long-term performance projections for the PA, engineering-scale integrated testing, and waste form qualification testing.

Cementitious Monolith After 140 Days of Leach Testing

COST AND SCHEDULE SUMMARY

WBS numbers: N/A

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18</th>
<th>FY19</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
</tr>
<tr>
<td>Formulation Development</td>
<td>█</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Performance Testing for IDF PA</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Engineering Scale Testing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Waste Form Qualification</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1000</td>
<td>$4600</td>
<td>$5600</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

RPP-029, WTP LAW/EMF Hot Commissioning is Delayed

<table>
<thead>
<tr>
<th>Contractor Contact:</th>
<th>DOE ORP Contact:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elvie Brown</td>
<td>Gary Pyles</td>
</tr>
<tr>
<td>Phone: (509)376-7908</td>
<td>Phone: (509)376-2670</td>
</tr>
<tr>
<td>Email: <a href="mailto:Elvie_Brown@rl.gov">Elvie_Brown@rl.gov</a></td>
<td>Email: <a href="mailto:Gary.Pyles@orp.doe.gov">Gary.Pyles@orp.doe.gov</a></td>
</tr>
</tbody>
</table>
LOW TEMPERATURE WASTE FORM PROCESS

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 Facility has limited capacity and is projected to be able to treat about one-third of the total LAW within the mission duration timeframe, bounded for HLW treatment. Additional LAW immobilization capacity is needed for timely completion of the waste treatment mission and to avoid protracted interruptions of the High-Level Waste Facility operations. Waste form performance data are needed to support a supplement analysis to the Tank Closure and Waste Management Environmental Impact Statement in order 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 needed to support a future DOE Record of Decision on what process to use for supplemental immobilization of Hanford Site LAW.

TECHNOLOGY SOLUTION

The development approach is described in a Technology Maturation Plan that is patterned after the DOE-G-413.1-4A 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.
ADDITIONAL TECHNICAL INFORMATION

The initial phases of formulation development and testing were funded in FY 2012 through FY 2015 with a program to mature the technology by 2019 to support a DOE decision by 2023.

Curing Mold Filled with Cast Stone

COST AND SCHEDULE SUMMARY

WBS number: 5.3.12.2.2.11

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY18 Q1</th>
<th>FY18 Q2</th>
<th>FY18 Q3</th>
<th>FY18 Q4</th>
<th>FY19 Q1</th>
<th>FY19 Q2</th>
<th>FY19 Q3</th>
<th>FY19 Q4</th>
<th>FY20 Q1</th>
<th>FY20 Q2</th>
<th>FY20 Q3</th>
<th>FY20 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulation Optimization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$5</td>
</tr>
<tr>
<td>Actual Waste Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Scale Integrated Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Term Performance – PA Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$2500</td>
<td>$2500</td>
<td>$3500</td>
<td>$8500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

OPP-004, Alternate Supplemental Treatment Technology Development Results in an Acceptable Process That Improves Cost and /or Schedule Performance Against the Assumed Baseline

Contractor Contact: David Swanberg
Phone: (509)376-0710
Email: David_J_Swanberg@rl.gov

DOE ORP Contact: Gary Pyles
Phone: (509)376-2670
Email: Gary.Pyles@orp.doe.gov
IDF LONG-TERM WASTE FORM DURABILITY STUDY (LYSIMETER DATA)

TEDS ID: DTW-08          Priority: Low          Rank: N/A

TECHNOLOGY NEED

Validation of Performance Assessment (PA) (RPP-RPT-59958) models using field results from monitored and well understood/documented lysimeter tests are needed to improve stakeholder confidence in disposal facility and waste form performance. Increased understanding of model performance can allow modelers to better understand how well the model predicts Integrated Disposal Facility (IDF) conditions and allow reduction in conservatism in release estimates, resulting in better utilization of the IDF and lower IDF closure requirements and costs. Data regarding formation of secondary phases formed at the waste/environment interface. The secondary phases are used as model inputs and drive long-term chemical interaction estimates; secondary phases are currently obtained from accelerated tests where both surface area and temperature are increased, frequently with deionized water (also very corrosive). This work is intended to provide data on secondary phases formed over a much longer period of time at temperatures and conditions closer to the actual disposal environment than testing to date.

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 is planned to be on cementitious waste forms but glass will be included.
ADDITIONAL TECHNICAL INFORMATION

Load lysimeter with simulated glass and grout waste forms. Systematically retrieve samples, analyze them, and compare results to models run to simulate sample/lysimeter history; including analysis for secondary phases. Monitor parameters needed as model inputs and measure waste form release rates for use in validating PA models.

COST AND SCHEDULE SUMMARY

<table>
<thead>
<tr>
<th>WBS number: 5.03.06.01.04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project or Activity</td>
</tr>
<tr>
<td>Facility Cleanup &amp; Upgrades</td>
</tr>
<tr>
<td>Initial Test Plan</td>
</tr>
<tr>
<td>Load Lysimeters</td>
</tr>
<tr>
<td>Monitor Tests</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

N/A

Contractor Contact: Steve Kelly
Phone: (509)376-0717
Email: Steven_E_Kelly@rl.gov

DOE ORP Contact: Gary Pyles
Phone: (509)376-2670
Email: Gary.Pyles@orp.doe.gov
4.4.2  DTW Catalog Sheets – Needed

**RANKED LOW**

DTW-06  Advance Offsite Transportation Capability ........................................... 4-131
ADVANCE OFFSITE TRANSPORTATION CAPABILITY

TEDS ID: DTW-06  Priority: Low  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 Nuclear Regulatory Commission, Department of Transportation, and DOE).

TECHNOLOGY NEED

Establish criteria to procure 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).

RISKS AND OPPORTUNITIES

DFLAW-006-R, ILAW Transporters LTA

Contractor: Allan (Rick) Tedeschi  Phone: (509)373-6018
Email: Allan_R_Rick_Tedeschi@rl.gov

ORP: Kaylin Burnett  Phone: (509)372-0622
Email: Kaylin_W_Burnett@orp.doe.gov
4.5 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., secondary liquid waste [SLW] or secondary solid waste [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 SLW 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 SLW 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 (TcO4-), 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 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 (TC&WM EIS) 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 SLW 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. SLW 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 SLW.

2. **SSW** — These wastes (i.e., radioactive solid wastes) are non-liquid waste debris and byproducts of Hanford Site operations.

3. **SLW** — 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 4.5.1 and 4.5.2 include the catalog sheets for the technologies that fall under the MW function.
4.5.1 MW Catalog Sheets – Planned

RANKED HIGH

MW-02 Ammonia Vapor Mitigation ........................................................................... 4-136
This page intentionally left blank.
AMMONIA VAPOR MITIGATION

TEDS ID: MW-02  Priority: High  Rank: 5

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

By investigating the possibilities via literature review and small-scale simulant tests, a list of potential resolutions to the ammonia vapor issue can be identified. Following this phase of scoping possible technologies, the waste treatment vendor is expected to take responsibility for all aspects of ammonia vapor management with low-salt waste grout. A range of future outcomes are possible; the vendor could decide to use existing technology (e.g., self-contained breathing apparatus, off-gas scrubbers) or further demonstrate an alternative grout formulation to mitigate/eliminate the ammonia vapor issue.

Technology Maturation Level:
Laboratory Testing

National Laboratory Involvement?
Yes

Submitted as Grand Challenge?
No

Laboratory Set Up
ADDITIONAL TECHNICAL INFORMATION

AMMONIA VAPOR MITIGATION

TEDS ID: MW-02 Continued

COST AND SCHEDULE SUMMARY

WBS number: 5.3.10.3.2

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>FY2018 Q1</th>
<th>FY2018 Q2</th>
<th>FY2018 Q3</th>
<th>FY2018 Q4</th>
<th>FY2019 Q1</th>
<th>FY2019 Q2</th>
<th>FY2019 Q3</th>
<th>FY2019 Q4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen alternative grout formulations</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Engineering Demonstration of grouting process</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>NH3 mitigation process development</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$2,000</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

RISKS AND OPPORTUNITIES

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

Contractor Contact: David Swanberg
Phone: (509)376-0710
Email: David_J_Swanberg@rl.gov

DOE ORP Contact: Gary Pyles
Phone: (509)376-2670
Email: Gary.Pyles@orp.doe.gov
4.5.2 MW Catalog Sheets – Needed

**RANKED HIGH**

MW-15 At-Tank Technetium and Iodine Removal and Disposition ....................... 4-139

**RANKED MEDIUM**

MW-08 ETF Organic Destruction Unit Operation .................................................. 4-140
MW-09 Replace ETF Peroxide Destruction Unit Operation ..................................... 4-141
MW-10 Remotely Operated or Automated ETF Internal Tank Cleaning Device .... 4-142
MW-12 Upgrade Solid Waste Information and Tracking System ......................... 4-143
MW-13 Transportation Requirements for New Equipment Disposal .................... 4-144
AT-TANK TECHNETIUM AND IODINE REMOVAL AND DISPOSITION

TEDS ID: MW-15  Priority: High  Rank: 26

TECHNOLOGY NEED

Technetium-99 (Tc-99) and iodine-129 (I-129) are long-lived, highly mobile radionuclides that are volatile at glass melting temperatures. Modular ion exchange treatment methods can be performed independent of the baseline Waste Treatment and Immobilization Plant process flowsheet. This technology could be used to remove and treat troublesome components from the tank waste inventory and completely remove them from the Hanford Site. This is expected to improve overall waste processing, remove radioactive source terms from the Integrated Disposal Facility waste inventory and protect the Columbia River.

TECHNOLOGY SOLUTION

Work needs to be done to develop technology maturation and development for “tunable” Tc-selective and I-selective ion exchange 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.

RISKS AND OPPORTUNITIES

N/A

Contractor: Jason Vitali
Phone: (509)376-6751
Email: Jason_R_Vitali@rl.gov

ORP: Elaine Diaz
Phone: (509)373-9757
Email: Elaine_N_Diaz@orp.doe.gov
ETF ORGANIC DESTRUCTION UNIT OPERATION

TEDS ID: MW-08  Priority: Medium  Rank: N/A

TECHNOLOGY NEED

The existing Effluent Treatment Facility (ETF) ultraviolet oxidation treatment unit is no longer supported with spare parts or technical assistance by the vendor. To meet the estimated organic constituent treatment demand, the organic treatment unit must not only be replaced but enhanced. A complete organic constituent characterization of the expected Waste Treatment and Immobilization Plant (WTP) waste stream characterization is needed for ETF to assess the impacts of higher organic loading to the facility.

TECHNOLOGY SOLUTION

Determine an enhanced or replacement organic treatment technology for the existing ETF ultraviolet oxidation unit. Update and enhance (through paper study based upon the delisting petition (DOE/RL-98-62, Rev. 1) the WTP organic characterization. Evaluate the ETF organic treatment capability against the characterization.

RISKS AND OPPORTUNITIES

RPP-035, WTP LAW Throughput Rate Does Not Meet Plan

Contractor: Dale Halgren  Phone: (509)376-9988  Email: Dale_L_Halgren@rl.gov
ORP: Richard Valle  Phone: (509)376-7256  Email: Richard_J_Valle@orp.doe.gov
REPLACE ETF Peroxide Destruction Unit Operation

TEDS ID: MW-09  Priority: Medium  Rank: N/A

**TECHNOLOGY NEED**

The Effluent Treatment Facility (ETF) needs a unit operation that has the capability to remove all the hydrogen peroxide from the process wastewater downstream from the ultraviolet oxidation unit. The existing ETF peroxide destruction unit is not operable due to impacts of the current method to downstream operations. In addition one of the unit vessels has failed. During the period of attempted operation the system did not meet the destruction capability criteria. Due to the low overall organic content of the current feed the peroxide destruction unit operation is not critical. Peroxide destruction is necessary when treatment of Waste Treatment and Immobilization Plant wastewaters begin. Higher organic loading requires an excess of hydrogen peroxide addition to the ultraviolet oxidation unit and subsequent peroxide destruction is needed to protect the downstream reverse osmosis system.

**TECHNOLOGY SOLUTION**

Technology investigation and analysis. Technology selection and testing.

---

**RISKS AND OPPORTUNITIES**

RPP-053, ETF Throughput Rate is LTA

**Contractor:** Dale Halgren  
Phone: (509)376-9988  
Email: Dale_L_Halgren@rl.gov  

**ORP:** Richard Valle  
Phone: (509)376-7256  
Email: Richard_J_Valle@orp.doe.gov
HANFORD SITE
US DEPT OF ENERGY

NEEDED

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

TECHNOLOGY NEED

The Effluent Treatment Facility (ETF) process tanks build-up scale that cannot be removed by soaking or recirculating with chemicals. Scale build-up provides a mechanism for accelerated corrosion and inhibits Resource Conservation and Recovery Act-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 operation.

TECHNOLOGY SOLUTION

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. A functional cleaning technology can 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.

RISKS AND OPPORTUNITIES

RPP-053, ETF Throughput Rate is LTA

Contractor: Dale Halgren
Phone: (509)376-9988
Email: Dale_L_Halgren@rl.gov

ORP: Richard Valle
Phone: (509)376-7256
Email: Richard_J_Valle@orp.doe.gov
### 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 needs to be upgraded to include WTP-specific items. This requires the participation of the SWITS maintenance contractor CH2M HILL Plateau Remediation Company (CHPRC). CHPRC contracted to operate the Integrated Disposal Facility; CHPRC needs to decide what program to use for tracking waste into and out of the facility. If they decide not to use SWITS, then this is not an issue.

### RISKS AND OPPORTUNITIES

N/A
TRANSPORTATION REQUIREMENTS FOR NEW EQUIPMENT DISPOSAL

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 at some point needs to be replaced and disposed. Need to ensure there is an appropriate package to transport these items for disposal. Sampling aspects need to be considered to ensure the proper packaging is developed so that the samples can be transported per applicable regulations.

TECHNOLOGY SOLUTION

Identify unique equipment or samples and ensure there is a transportation package for that item. Examples are tank waste samples that are larger in volume than 1 L. High dose high curie large equipment that need to be disposed of.

RISKS AND OPPORTUNITIES

RPP-054, Facility Closure Costs Are Not Fully Evaluated

Contractor: Douglas Swenson
Phone: (509)373-9279
Email: Douglas_Swenson@rl.gov

ORP: Glyn Trenchard
Phone: (509)373-4016
Email: Glyn_d_Trenchard@orp.doe.gov
5.0 TECHNOLOGY DEVELOPMENT FUNDING AND PRIORITIES

WRPS takes advantage of the DOE National Laboratory network, academia, and industry experts to develop innovative approaches to enhance our ability to meet the mission needs. While Pacific Northwest National Laboratory (PNNL) has received a significant share of the overall investment in technology in FY 2018, 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. Additionally, difficulties in funding with the National Laboratories (other than PNNL) was observed in FY 2018 due to a Policy Memorandum (NMPD-18-0033) that clarified the use of inter-entity work orders instead of the Strategic Partnership Program (SPP) to facilitate the fund transfers between EM Site contractors. However, the Policy Memorandum unintentionally created a funding transfer issue between non-integrated contractors. The DOE program and staff offices, including EM, the Chief Financial Officer, and the Office of Management, are continuing to work to resolve this issue.

In addition to the National Laboratory network, investments in technology were also made with academic institutions to develop under-tank nondestructive examination inspection techniques, to develop an autonomously instrumented vehicle to support monitoring activities, and to mature an ultra-high performance cementitious composite for evaluation with the solid secondary waste form program.

Figure 5-1. National Laboratory Support.
(FY 2018 Spend Forecast as of April 2018)*
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. During FY 2018, approximately 12% of technology development funding was invested in ILAW glass testing, 12% was invested in maturation and turnover of vapor monitoring and detection equipment, and 11% was invested in operation of the radioactive waste test platform. Additional investments in activities, such as LAWPS / tank side cesium removal technology maturation, DFLAW maturation, vapors, project management, alternate retrieval technology development, and technology development in support of operational improvements also occurred in FY 2018.

DOE Strategic Initiatives and associated technologies mentioned in DOE letter 18-WSC-0016 are of primary importance to the RPP mission. These technologies initially receive a high-priority ranking. The initiatives are summarized in the subsequent bullet points, and the technology elements that address each initiative are identified.

- **Tank Waste and Secondary Waste Treatment and Tank Closure:**
  - Glass program
  - Advanced grout formulation technology development
  - DTW-3, DTW-7, MW-2, and MW-15 address this initiative.
- Comprehensive Vapors Actions:
  - Provide support and develop technology for managing Hanford tank waste vapors and the key performance parameters specified in ORP direction letter 17-TF-0015
  - Support the WRPS vapors Integrated Safety Management strategy
  - Develop instrumentation for monitoring on active stack ventilation and IH area and/or personnel monitoring
  - Continue to improve hazards identification and develop and test controls technologies
  - As needed, pursue other specific engineering, administrative, and personal protective equipment controls to support work scope priorities as determined by ORP, WRPS Operations and Industrial Hygiene groups.
    - MTW-24, MTW-40, and MTW-41 address this initiative.

- Other work to support safe stabilization and disposal of waste:
  - LAWPS/Tank side cesium removal supporting technology development
  - Study of ideas to simplify or optimize DFLAW flowsheet.
    - PTW-40, PTW-48, and PTW-52 address this initiative.
• Tank Integrity Program:
  – Emphasize proactive measures to detect, prevent, and address corrosion in DSTs.
  – *MTW-09, MTW-11, MTW-15, and MTW-73 address this initiative.*
• Cross-Site Transfer Line:
  – Support Operations and Engineering as necessary.
  – *No TEDS address this initiative because currently no technology developments are needed in this area.*

Most of the DOE strategic initiatives were addressed if technology development was needed in those areas. Specifically for the cross-site transfer line, the operations and engineering groups do not anticipate any improvements needed for the technology. However, other technology elements have been identified that may result in delaying or potentially eliminating the reliance on the cross-site transfer line (e.g., remote treatment opportunities). These elements will continue to be tracked in this Roadmap, but are not directly linked to the cross-site transfer line because they are opportunities versus baseline project needs.

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.
## Table 5-1. Priority Ranking of High-Priority TEDS Sheets.

<table>
<thead>
<tr>
<th>Rank</th>
<th>TEDS</th>
<th>Title</th>
<th>Planned</th>
<th>Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PTW-52</td>
<td>DFLAW Pretreatment Operations Technology Maturation</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>2</td>
<td>MTW-79</td>
<td>Autonomous Instrumented Vehicle</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3</td>
<td>MTW-75</td>
<td>Super-Hydrophobic Metal Surfaces to Reduce Equipment Contamination</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>4</td>
<td>MTW-73</td>
<td>Tertiary Leak Detection and Foundation Robotic Inspection</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5</td>
<td>MW-02</td>
<td>Ammonia Vapor Mitigation</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>MTW-11</td>
<td>DST Primary Tank Bottom Volumetric Inspection</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>MTW-24</td>
<td>Vapor Monitoring, Detection &amp; Remediation (VMDR)</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>MTW-82</td>
<td>Tank Annulus Floor Cleaning</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>RTW-54</td>
<td>Tank Waste Modular Treatment Study</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>MTW-15</td>
<td>Visual Inspection Primary Tank Bottoms</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>RTW-56</td>
<td>Technology to Support Risk-Based Retrieval and Closure</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>RTW-39</td>
<td>Risk Informed Tank Retrieval Strategy</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>PTW-51</td>
<td>Nitrite-Hydroxide Solubility to Determine Aluminum Solubility in DFLAW</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>RTW-24</td>
<td>Two-Step Characterization of 241-C-301 Catch Tank Content</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>MTW-09</td>
<td>Automated DST Annulus Camera System</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>PTW-40</td>
<td>High-Level Waste Phased Approach</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>DTW-03</td>
<td>Immobilized ILAW Glass Testing for IDF PA Support</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>PTW-48</td>
<td>Prevention of Hydrogen Gas Buildup</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>RTW-08</td>
<td>In-Tank Mechanical Waste Gathering System</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>MTW-41</td>
<td>Analytical Method Development for Compounds of Concern</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>PTW-49</td>
<td>Feasibility of Removing Nitrates from the LAW Feed</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>RTW-55</td>
<td>Hanford Waste End Effector</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>MTW-81</td>
<td>Radiation Tolerant Multi-Use Manipulator System</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>DTW-07</td>
<td>Solidification and Stabilization of Solid Secondary Waste</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>MTW-74</td>
<td>Measure Breathing Rates in Selected SX Tanks</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>MW-15</td>
<td>At-Tank Technetium and Iodine Removal and Disposition</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>RTW-25</td>
<td>Highly Flowable Grout</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>RTW-02</td>
<td>Residual Volume Measuring System (RVMS)</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>RTW-53</td>
<td>Three-Dimensional Flash LIDAR to Map Waste Tanks</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>MTW-37</td>
<td>Tank Waste Characterization and Identification</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>MTW-57</td>
<td>Predicting Behavior of Mercury in EMF</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>RTW-01</td>
<td>Development of Next Generation Retrieval Waste Sampling Tools</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
6.0 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 associated with these objectives, DOE is striving to improve implementation of new technologies. The identification of these technologies comes from a variety of sources, collected and prioritized in the Roadmap. The informational inputs and outputs of the Roadmap are identified in Figure 3-1. A prioritization process, described in Appendix B, is used to determine high-priority technologies from medium- or low-priority technologies based on necessity, urgency, and stakeholder requirement logic.

A comprehensive 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 sheets input, the technology needs may be tied to the actual projects or require development activities. 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 strives to reconcile individual technology development activities, identifying the highest priority technology needs each year and combining efforts where possible.

The Roadmap catalogues 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.
7.0 REFERENCES


ANSI/ANS-8, Fissionable Material Outside Reactors, American Nuclear Society, Columbus, Ohio.


APPENDIX A

TECHNOLOGY ELEMENT DESCRIPTION

SUMMARY FORM
Figure A-1. TEDS Form

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
Submit 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)

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

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.
Figure A-2. TEDS Form, page 2

Technology Element Description Summary

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 schedule summary After"):  

<table>
<thead>
<tr>
<th>Project or Activity</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter task description</td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Funding in thousands (000s)</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>

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.
APPENDIX B

RANKING AND RATING PROCESS
B1.0 Technology Prioritization

Given limitations of funding and that some tasks require development of predecessor tasks prior to implementation, not all identified technology tasks can be performed concurrently. The method depicted in Figure B-1 was established to prioritize the various technology actions. The ranking/comparison system takes into account the urgency of the need and the potential benefit of the proposed technology solution. 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.

Figure B-1. Mission-Driven Technology Activity Prioritization Logic.

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 River Protection Project (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? The U.S. Department of Energy (DOE), Office of River Protection (ORP) strategic technology needs and priorities provided by ORP in letter 18-WSC-0016, “Contract Number DE-AC27-08RV14800 – Fiscal Year 2018 Preliminary Budget Guidance for Technology Roadmap and Chief Technology Office” (identified in the lower left-hand box of
Figure B-1) are considered “need to haves.” Figure B-1 also illustrates the general logic for prescreening and prioritizing technology actions used by the prioritization council. This basic diagram guides the prioritization process.

The prioritization methodology measured the technology activities against a predetermined set of criteria defined by technology and subject matter expert representatives from each functional area. The prioritization council comprises one expert representative of each functional area, plus five additional impartial members who are familiar with the RPP mission scope to facilitate the process. For this effort, the impartial council members represented ORP, the Chief Technology Office, One System Mission Planning, Performance Measurement Baseline, and Life-Cycle Baseline.

Each Technology Element Description Summary (TEDS) is prescreened to determine the technology needs that are the considered high priority. Only these prescreened TEDS sheets are brought before the prioritization council to further prioritize mission-critical technologies. A set of evaluation criteria and a scoring protocol are defined to determine relative priority 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 mission enhancement impacts.

As part of the overall priority evaluation, additional incremental scoring based on the level and extent of the impact for each criterion was also taken into account. The final priority value is scored according to the summation of the weighted high, medium, and low attributes. This process is summarized in Table B-1.

The ranking process results in a weighted raw score and a whole number ranking for each item. Some items resulted in the same weighted score and were assigned the same whole number priority. A sub-ranking process was applied that further differentiated rank according to category weight by adding a relative decimal value. To discriminate between a tie result, a re-evaluation of the high, medium, and low category scores was performed and the council determined the sub-ranking. The results of the final ranking are presented in Table B-2.

B2.0 References


### Table B-1: Scoring Protocols for Priority Determination.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>High (3x weight)</th>
<th>Medium (2x weight)</th>
<th>Low (1x weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A) Safety</td>
<td>(B) DOE Commitment</td>
<td>(C) Strategic Initiative</td>
</tr>
<tr>
<td>Gauge for relative criteria score</td>
<td>Reduce specifically identified safety risk?</td>
<td>Contribute to DOE commitment or milestone completion?</td>
<td>Support ORP identified Strategic Initiative?</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>Needed for Consent Decree or DFLAW</td>
<td>Yes, directly supports initiative</td>
</tr>
<tr>
<td>2</td>
<td>Potentially</td>
<td>Needed for TPA, DOE HQ or public commitment</td>
<td>Enhances an initiative but not critical path</td>
</tr>
<tr>
<td>1</td>
<td>No</td>
<td>No direct impact</td>
<td>No direct impact</td>
</tr>
</tbody>
</table>

Total = \(3\Sigma(\text{high criteria scores}) + 2\Sigma(\text{medium criteria scores}) + 1\Sigma(\text{low criteria scores})\)


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.
WRPS = Washington River Protection Solutions LLC.
Table B-2. Ranking Sheet—See Table 5-1 for TEDS Titles.

<table>
<thead>
<tr>
<th>TEDS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>Un-weighted Score</th>
<th>Weighted Score</th>
<th>Final Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTW-52</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>19</td>
<td>42.1</td>
<td>1</td>
</tr>
<tr>
<td>MTW-79</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>20</td>
<td>42.1</td>
<td>2</td>
</tr>
<tr>
<td>MTW-75</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>20</td>
<td>42.1</td>
<td>3</td>
</tr>
<tr>
<td>MTW-73</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td>41.8</td>
<td>4</td>
</tr>
<tr>
<td>MW-2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>18</td>
<td>41.1</td>
<td>5</td>
</tr>
<tr>
<td>MTW-11</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>20</td>
<td>40.8</td>
<td>6</td>
</tr>
<tr>
<td>MTW-24</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>18</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>MTW-82</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>19</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>RTW-54</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>17</td>
<td>38.3</td>
<td>9</td>
</tr>
<tr>
<td>MTW-15</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>19</td>
<td>37.8</td>
<td>10</td>
</tr>
<tr>
<td>RTW-56</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>17</td>
<td>37.4</td>
<td>11</td>
</tr>
<tr>
<td>RTW-39</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>17</td>
<td>37.4</td>
<td>12</td>
</tr>
<tr>
<td>PTW-51</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>18</td>
<td>36.8</td>
<td>13</td>
</tr>
<tr>
<td>RTW-24</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>17</td>
<td>35.9</td>
<td>14</td>
</tr>
<tr>
<td>MTW-9</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>18</td>
<td>35.7</td>
<td>15</td>
</tr>
<tr>
<td>PTW-40</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>17</td>
<td>35.2</td>
<td>16</td>
</tr>
<tr>
<td>DTW-3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>17</td>
<td>34.9</td>
<td>17</td>
</tr>
<tr>
<td>PTW-48</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>16</td>
<td>34.7</td>
<td>18</td>
</tr>
<tr>
<td>RTW-8</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>34.5</td>
<td>19</td>
</tr>
<tr>
<td>MTW-41</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>15</td>
<td>33.7</td>
<td>20</td>
</tr>
<tr>
<td>PTW-49</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>33.1</td>
<td>21</td>
</tr>
<tr>
<td>RTW-55</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>15</td>
<td>32.3</td>
<td>22</td>
</tr>
<tr>
<td>MTW-81</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>32</td>
<td>23</td>
</tr>
<tr>
<td>DTW-7</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>15</td>
<td>31.8</td>
<td>24</td>
</tr>
<tr>
<td>MTW-74</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>16</td>
<td>31.8</td>
<td>25</td>
</tr>
<tr>
<td>MW-15</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>15</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>RTW-25</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>15</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>RTW-2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>28.9</td>
<td>28</td>
</tr>
<tr>
<td>RTW-53</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>28.9</td>
<td>29</td>
</tr>
<tr>
<td>MTW-37</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>28.7</td>
<td>30</td>
</tr>
<tr>
<td>MTW-57</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>25.9</td>
<td>31</td>
</tr>
<tr>
<td>RTW-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>14</td>
<td>25.9</td>
<td>32</td>
</tr>
</tbody>
</table>
APPENDIX C

RETIRED TECHNOLOGY ELEMENT DESCRIPTION
SUMMARIES SPREADSHEET
<table>
<thead>
<tr>
<th>TEDS</th>
<th>Title</th>
<th>Basis for Retirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTW-04</td>
<td>Technology to Propagate Information to Feed into IDF PA</td>
<td>Included in DTW-3</td>
</tr>
<tr>
<td>MTW-05</td>
<td>242-A Evaporator Operating Chemistry Limits for LAW Returns</td>
<td>Implemented</td>
</tr>
<tr>
<td>MTW-08</td>
<td>Evaluate Additional Nondestructive Examination (Flash Thermography)</td>
<td>New technology exists</td>
</tr>
<tr>
<td>MTW-18</td>
<td>Synthetic and Tandem Synthetic Aperture Focusing Techniques (SAFT and T-SAFT)</td>
<td>New technology exists</td>
</tr>
<tr>
<td>MTW-23</td>
<td>Mitigating Tank Farm Vapor Sources</td>
<td>Implemented</td>
</tr>
<tr>
<td>MTW-33</td>
<td>SST and DST Integrity Evaluation Tools</td>
<td>New technology exists</td>
</tr>
<tr>
<td>MTW-49</td>
<td>DFLAW Returns Corrosion Testing</td>
<td>Implemented</td>
</tr>
<tr>
<td>MTW-56</td>
<td>Update Best Basis Inventory for Organic Constituents of Potential Concern</td>
<td>No longer needed - mission need changed</td>
</tr>
<tr>
<td>MTW-67</td>
<td>Steerable Needle for Tank Bottom Inspection</td>
<td>Combined with another TEDS</td>
</tr>
<tr>
<td>MW-04</td>
<td>High-Level Waste Melter Disposal</td>
<td>No technology development needed</td>
</tr>
<tr>
<td>RTW-37</td>
<td>Tank Waste Residual Volume Measurement System</td>
<td>Combined with RTW-2</td>
</tr>
<tr>
<td>RTW-40</td>
<td>Predicting Formation of Solids and Gels during Waste Retrievals</td>
<td>Reclassified as non-technology development</td>
</tr>
<tr>
<td>RTW-42</td>
<td>Using Scaled Mining Equipment for Reducing Water Use during Retrieval</td>
<td>Combined with RTW-8</td>
</tr>
<tr>
<td>RTW-46</td>
<td>MARS-V Alternative and Dry Method for Waste Gathering</td>
<td>Combined with RTW-8</td>
</tr>
<tr>
<td>RTW-47</td>
<td>MARS-V Enhancements for Use in Leaking Tanks</td>
<td>Combined with RTW-55</td>
</tr>
<tr>
<td>RTW-50</td>
<td>Evaluate SLIMS and Cone Penetrometers for SST Retrievals</td>
<td>New technology exists</td>
</tr>
<tr>
<td>PTW-17</td>
<td>Cross-Flow Filtration and IX for LAWPS</td>
<td>Combined with another TEDS</td>
</tr>
<tr>
<td>PTW-18</td>
<td>Cross-Flow Filtration Technology (Process)</td>
<td>Combined with another TEDS</td>
</tr>
<tr>
<td>PTW-19</td>
<td>Ion Exchange Using sRF</td>
<td>Combined with another TEDS</td>
</tr>
<tr>
<td>PTW-21</td>
<td>Resin Handling System</td>
<td>No longer needed</td>
</tr>
<tr>
<td>PTW-31</td>
<td>DFLAW Feed Qualification Processes</td>
<td>No longer needed - mission need changed</td>
</tr>
<tr>
<td>PTW-32</td>
<td>Optimization of IX Regeneration Process on Secondary Liquid Waste Volume Reduction</td>
<td>No longer needed - mission need changed</td>
</tr>
<tr>
<td>PTW-43</td>
<td>Multiple Cycle Testing of sRF Resin in a Radiation Field</td>
<td>No longer needed - mission need changed</td>
</tr>
<tr>
<td>PTW-47</td>
<td>Optimize Cesium IX Column Series Elution Process.</td>
<td>New technology exists</td>
</tr>
</tbody>
</table>