June 12, 2020

20-TF-0032

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Smith:

COMPLETION OF TRI-PARTY AGREEMENT MILESTONE M-045-93

This letter notifies the Washington State Department of Ecology (Ecology) that the U.S. Department of Energy, Office of River Protection is considering Hanford Federal Facility Agreement and Consent Order milestone M-045-93 complete.

M-045-93 - Submit for Ecology's review and approval, as a Primary Document, a report that includes the following: (1) a description and analysis of each alternative method and technology for removing drainable liquids from the single-shell tanks (SST); (2) a proposed selection of the preferred liquid removal method and technology for each SST identified in the SST Liquid Report; and (3) a proposed sequence for removing drainable liquids from SSTs identified in the SST Liquids Report.

RPP-RPT-62098, Rev. 0 satisfies all three points in M-045-93 and is attached. Per Hanford Federal Facility Agreement and Consent Order, Section 9.2, "Document Review and Comment Process," and figure 9-1, Ecology has 45 days to comment.

If you have any questions, please contact me on (509) 376-3567.

Sincerely,

Brian A. Harkins
Digitally signed by Brian A. Harkins
Date: 2020.06.12 14:21:22 -07'00'

Brian A. Harkins
Tri-Party Agreement Manager
Office of River Protection

TF:DMS

Attachment:
RPP-RPT-62098

cc: See page 2

cc w/attach:
M. Barnes, Ecology
D. R. Einan, EPA
S. Leckband, HAB
J. J. Lyon, Ecology
N. Menard, Ecology
K. Niles, ODOE
M. J. Turner, MSA
Administrative Record
Environmental Portal
WRPS Correspondence

cc w/o attach:
J. Bell, NPT
R. Buck, Wanapum
L. Contreras, YN
M. Murphy, CTUIR

Attachment
20-TF-0032

Single-Shell Tanks Liquids Retrieval Study
RPP-RPT-62098 Rev.0

(41 Pages Including Cover Sheet)

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

Release Stamp

DATE: Jun 08,2020

HANFORD RELEASE

1. **Doc No:** RPP-RPT-62098 **Rev.** 00

2. **Title:**
Single-Shell Tanks Liquids Retrieval Study

3. **Project Number:** ☒N/A

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

5. **USQ Number:** ☒ N/A RPP-27195

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type: public

7. **Approvals**

Title	Name	Signature	Date
Checker	Brelia, Robert C	*Brelia, Robert C*	05/22/2020
Clearance Review	Aardal, Janis D	*Aardal, Janis D*	06/08/2020
Document Control Approval	Hood, Evan	*Hood, Evan*	05/28/2020
Originator	White, Katie A	*White, Katie A*	05/22/2020
Other Approver	Subramanian, Karthik H	*Subramanian, Karthik H*	05/27/2020
Other Approver	Gerle, Michael D	*Gerle, Michael D*	05/27/2020
Responsible Engineer	Houghton, David J	*Houghton, David J*	05/27/2020
Responsible Manager	Houghton, David J	*Houghton, David J*	05/27/2020

8. **Description of Change and Justification**

Initial Release

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

Document Number	Rev.	Title

12. **Impacted Documents (Outside SPF):**

N/A

13. **Related Documents** ☒N/A

Document Number	Rev.	Title

14. **Distribution**

Name	Organization
Hein, Kyle D	MISSION INTGR & WFD/OPERATIONS
Houghton, David J	TANK FARM PROJECTS & DFLAW ENG
Subramanian, Karthik H	ENGINEERING

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: Single Shell Tanks Liquid Retrieval Study	Information Category: ☐ Abstract ☐ Journal Article ☐ Summary ☐ Internet ☐ Visual Aid ☐ Software ☐ Full Paper ☐ Report ☑ Other Type
Publish to OSTI? ☐ Yes ☑ No	
Trademark/Copyright "Right to Use" Information or Permission Documentation	Yes ☐ NA ☑
Document Number: RPP-RPT-62098 Revision 0	Date: June 2020
Author: Hein, Kyle D	

Part II: External/Public Presentation Information

Conference Name:	
Sponsoring Organization(s): Karhtik Subramanian	
Date of Conference:	Conference Location:
Will Material be Handed Out? ☐ Yes ☑ No	Will Information be Published? ☐ Yes ☑ No *(If Yes, attach copy of Conference format instructions/guidance.)*

Part III: WRPS Document Originator Checklist

Description	*Yes*	*N/A*	*Print/Sign/Date*
Information Product meets requirements in TFC-BSM-AD-C-01?	☐	☑	
Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	☐	☑	
If product contains pictures, safety review completed?	☐	☑	

Part IV: WRPS Internal Review

Function	*Organization*	*Date*	*Print Name/Signature/Date*
Subject Matter Expert	WRPS	06/07/2020	Hein, Kyle D IDMS Data File att.
Responsible Manager	WRPS	05/29/2020	Houghton, David J IDMS Data File att.
Other:			

Part V: IRM Clearance Services Review

Description	*Yes*	*No*	*Print Name/Signature*
Document Contains Classified Information?	☐	☒	If Answer is "Yes," ADC Approval Required Print Name/Signature/Date
Document Contains Information Restricted by DOE Operational Security Guidelines?	☐	☒	Reviewer Signature: Print Name/Signature/Date
Document is Subject to Release Restrictions? *If the answer is "Yes," please mark category at right and describe limitation or responsible organization below:*	☐	☒	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?	☐	☒	Information Clearance Specialist Approval APPROVED *By Janis D. Aardal at 9:06 am, Jun 08, 2020* Print Name/Signature/Date

When IRM Clearance Review is Complete – Return to WRPS Originator for Final Signature Routing (Part VI)

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part VI: Final Review and Approvals

Description	Approved for Release		Print Name/Signature
	Yes	N/A	
WRPS External Affairs	☒	☐	IDMS Data File att. Mc Cune, Hal C
WRPS Office of Chief Counsel	☒	☐	IDMS Data File att. Peters, Amber D
DOE – ORP Public Affairs/Communications	☒	☐	IDMS Data File att. Levardi, Yvonne M/Tyree, Geoff T
Other: ORP SME	☒	☐	IDMS Data File att. Stewart, Dustin M
Other: DOE OCC	☒	☐	IDMS Data File att. Zelen, Benjamin J

Comments Required for WRPS-Indicate Purpose of Document:

Dustin Stewart, DOE

To Ecology

APPROVED
By Janis D. Aardal at 9:06 am, Jun 08, 2020

Approved for Public Release;
Further Dissemination Unlimited

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: 06/08/2020

Was/Is Information Product Transferred to OSTI? ☐ Yes ☒ No

Forward Copies of Completed Form to WRPS Originator

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RPP-RPT-62098
Revision 0

Single-Shell Tank Liquids Retrieval Study

Prepared by

KA White
Sargent & Lundy for Washington River Protection Solutions, LLC

Date Published
May 2020

washington river protection solutions

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

Contract No. DE-AC27-08RV14800

SINGLE-SHELL TANK LIQUIDS RETRIEVAL STUDY

May 2020

prepared by

Sargent & Lundy
1100 Jadwin Avenue, Suite 400
Richland, Washington 99352-3425
(509) 946-3300

prepared for

Washington River Protection Solutions, LLC

EXECUTIVE SUMMARY

This report supports U.S. Department of Energy, Office of River Protection, compliance with *Hanford Federal Facility Agreement and Consent Order*, Milestone M-045-93, which describes the following deliverables:

"Submit for Ecology's review and approval, as a Primary Document, a report that includes the following: (1) a description and analysis of each alternative method and technology for removing drainable liquids from the SSTs; (2) a proposed selection of the preferred liquid removal method and technology for each SST identified in the SST Liquids Report; (3) a proposed sequence for removing drainable liquids from the SSTs identified in the SST Liquids Report."

Potentially applicable technologies were developed by reviewing commercial and Department of Energy technologies and brainstorming sessions with subject matter experts. The report describes, evaluates, and analyzes each of the technologies against a set of evaluation criteria which meets the first deliverable of the milestone.

Each of the nine selected technologies were assessed for applicability to the types of waste found in the single-shell tanks (i.e., supernatant, saltcake, sludge, and combinations). The screening process used established evaluation criteria to systematically rank and rate each technology against specific functions, criteria, and requirements. The technologies were assessed for removal of supernatant or interstitial liquids. This assessment meets the second deliverable of the milestone on a waste-type basis encompassing all single-shell tanks.

Raising the drainable interstitial liquid to the surface for forced-air evaporation was the preferred technology based upon the evaluation. Air recirculation with condensate recovery is the preferred forced-air system since consistent warm, dry, air is more effective than ambient air in evaporating liquids.

The plan for retrieval of waste from the single-shell tank system is developed utilizing specialized computer modeling techniques. The TOPSim model, RPP-RPT-59470, *TOPSim V3.0 Model Requirements*, is the primary software tool used to plan future retrieval activities and is used as the lifecycle model in support of the overall Hanford Mission. Shorter term Mission deliverables identifying single-shell tank retrieval priorities are outlined in RPP-40149-VOL2, *Integrated Waste Feed Delivery Plan: Volume 2 – Campaign Plan*, and RPP-PLAN-63778, *Multi-Year Operating Plan (MYOP)*, while ORP-11242, *River Protection Project System Plan* (currently System Plan 8), identifies the longer term future activities to meet the overall mission. System Plan 8 ultimately describes the current proposed sequence for removing any waste, including drainable liquids, from single-shell tanks which meets the third deliverable of the milestone.

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LIST OF TERMS

Abbreviations, Initialisms, and Acronyms

ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
HFFACO	Hanford Federal Facility Agreement and Consent Order
HIHTL	Hose-In-Hose Transfer Line
MYOP	Multi-Year Operating Plan
ORP	Office of River Protection
SST	Single-shell Tank

1.0 PURPOSE

This report supports the U.S. Department of Energy (DOE), Office of River Protection (ORP), compliance with *Hanford Federal Facility Agreement and Consent Order* (HFFACO), Milestone M-045-93. HFFACO Milestone M-045-93 states:

> "Submit for Ecology's review and approval, as a Primary Document, a report that includes the following: (1) a description and analysis of each alternative method and technology for removing drainable liquids from the SSTs; (2) a proposed selection of the preferred liquid removal method and technology for each SST identified in the SST Liquids Report; (3) a proposed sequence for removing drainable liquids from the SSTs identified in the SST Liquids Report."

2.0 BACKGROUND

The Hanford single-shell tank (SST) system consists of 149 SSTs located in 12 tank farms in the 200 East and 200 West Areas. The tanks in the SST system were built between 1943 and 1965. The radioactive and chemical process waste contained in the SSTs exists in one of three tank waste forms: supernatant, saltcake, or sludge. Seven combinations of tank waste forms appear in the SSTs:

- supernatant;
- saltcake;
- sludge;
- supernatant and saltcake;
- supernatant and sludge;
- saltcake and sludge; and
- supernatant, saltcake, and sludge.

The technology evaluation documented in this report addresses removal of drainable liquid from the SSTs. Information from RPP-PLAN-57554, *Portable Exhauster Usage Plan for Evaporation of Supernatant Liquid in Selected Single-Shell Tanks*, RPP-RPT-60305, *Single-Shell Tank Updated Drainable Interstitial Liquid Volumes – 2017*, and RPP-RPT-61929, *Evaporation of Water from Single-Shell Tanks using Active Ventilation*, was used in developing this report. Reports RPP-PLAN-57554 and RPP-RPT-61929 address SSTs with supernatant on the surface. Report RPP-RPT-60305 documents the drainable interstitial liquid volumes. Each report focuses on a different aspect of the drainable liquids contained within the SSTs.

The following definitions were obtained from the HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2019*, glossary.

- Supernatant is the liquid above the solids or in large liquid pools in the SSTs.

- Saltcake is soluble salts in waste storage tanks formed by the evaporation of liquid waste from nuclear reactor fuels reprocessing, and is characterized by high porosity, interstitial liquid drainability, and crystalline texture.

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

- Drainable interstitial liquid is defined as the volume of interstitial liquid (i.e., liquid in the pores around the waste particles) estimated to drain from a tank if a hole was present in the bottom centerline of an SST through both the steel liner and the concrete shell.

For the purposes of this report, the following terms are used.

- Drainable liquid is defined as the combination of drainable interstitial liquid and supernatant.

- A saltwell, or saltwell screen, is a stilling well into which interstitial liquid drains. The saltwell provides a drainable interstitial liquid reservoir from which the drainable interstitial liquid is pumped.

- Condensate is the liquid which is condensed from an airstream. The condensate is condensed from the airstream by reducing the temperature of the gases in the airstream.

- Saltwell liquor is defined as the saturated liquid contained in the SSTs in the form of supernatant or drainable interstitial liquid.

3.0 LIQUID RETRIEVAL TECHNOLOGIES

Nine technology options were evaluated during preparation of this report. The methodology used to identify the technology options, descriptions of the technologies, and their evaluations are contained in Appendix A. The technology options considered included: new technologies, proven technologies, and novel applications of proven technologies. Each technology option was scored twice against four criteria, once for supernatant removal applications and once for drainable interstitial liquid removal application. The criteria include the likelihood of success, design maturity, as low as reasonably achievable (ALARA), and reliability and complexity.

After completion of the ranking activity, the two highest scored technology options were selected for each liquid removal application. The four technology options include two proven technologies and two novel applications of proven technologies. The four technologies are:

- Single-pass ventilation,
- Air recirculation with condensate recovery,
- Enhanced saltwell pumping, and
- Ventilation or recirculation with interstitial liquid dispersion.

Single-pass ventilation is a proven technology that is used across the Hanford tank farms. Ambient air enters the tank where evaporation from the supernatant increases the humidity in the air. A fan pulls the air through a high efficiency particulate air filter prior to release via a stack to the surrounding environment. These emissions are monitored for radioactive emissions. Any condensation is collected and returned to the tank consistent with the current operations described in RPP-13033, *Tank Farms Documented Safety Analysis*. A single-pass ventilation system would not transport the condensate beyond the tank and ventilation system. Single-pass ventilation systems are used in the six double-shell tank farms. Single-pass ventilation systems are also deployed to support SST retrieval.

An air recirculation with condensate recovery system is a novel application of the single-pass ventilation system. The air leaving the SST travels first through a regenerating desiccant unit to dry the air and then through a heating unit. Condensate is gathered by the regenerating desiccant unit for disposal. The heating unit warms the air to above ambient temperature. The amount of vapor an airstream can carry increases as the air temperature increases. Warm, dry, air is returned to the tank where evaporation from the supernatant increases the humidity in the air and the cycle begins again. The airstream is not released to the environment and, therefore, a high efficiency particulate air filter and monitoring for radioactive emissions are not required for operation. The passive ventilation system in place on the tank would remain open consistent with the current operations described in RPP-13033.

Enhanced saltwell pumping is a proven technology used to remove drainable interstitial liquid. Enhanced saltwell pumping takes advantage of technological advances when selecting components for the system. A progressive cavity pump is deployed in a saltwell screen. The saltwell liquor removed from the saltwell screen by the pump would be collected and transported to a double-shell tank for storage until final disposal, consistent with the current operations described in RPP-13033.

Ventilation or recirculation with interstitial liquid dispersion system is a novel application of proven technologies. A progressive cavity pump would disperse saltwell liquor on the surface of the tank waste where evaporation would occur. A single-pass ventilation system or air recirculation with condensate recovery system would be used for the evaporation process. The system operation is consistent with the current operations described in RPP-13033.

Table 3-1 lists the applicable technologies for each waste form. Air recirculation with interstitial liquid dispersion is the preferred technology for SST drainable liquid removal. Warm, dry, air in combination with a dispersion system is effective for removing both forms of drainable liquid. Additional evaluation details are contained in Appendix A.

Table 3-1. Technology Application by Tank Waste Form.

Tank Waste Form	Single-Pass Ventilation	Air Recirculation with Condensate Recovery	Enhanced Saltwell Pumping	Ventilation or Recirculation with Interstitial Liquid Dispersion
Supernatant	X	X		X
Saltcake			X	X
Sludge			X	X
Supernatant and Saltcake	X	X	X	X
Supernatant and Sludge	X	X	X	X
Saltcake and Sludge			X	X
Supernatant, Saltcake, and Sludge	X	X	X	X

4.0 SUGGESTED EXECUTION ORDER

The plan for retrieval of waste from the single-shell tank system is developed utilizing specialized computer modelling techniques. The TOPSim model RPP-RPT-59470, *TOPSim V3.0 Model Requirements*, is the primary software tool used to plan future retrieval activities and is used as the lifecycle model in support of the overall Hanford Mission. Shorter term Mission deliverables identifying single-shell tank retrieval priorities are outlined in RPP-40149-VOL2, *Integrated Waste Feed Delivery Plan: Volume 2 – Campaign Plan*, and RPP-PLAN-63778, *Multi-Year Operating Plan (MYOP)*, while the *River Protection Project System Plan*, ORP-11242, (currently System Plan 8) identifies the longer term future activities to meet the overall mission. System Plan 8 ultimately describes the current proposed sequence for removing any waste, including drainable liquids.

5.0 CONCLUSIONS

HFFACO, Milestone M-045-93, Item 1, requires "…a description and analysis of each alternative method and technology for removing drainable liquids from the SSTs." Potentially applicable technologies were developed by reviewing commercial and DOE technologies and brainstorming sessions with subject matter experts. Section 3.0 and Appendix A contain the description, evaluation, and analysis of each technology which meets Item 1 of HFFACO, Milestone M-045-93.

Item 2 of HFFACO, Milestone M-045-93, requires "… a proposed selection of the preferred liquid removal method and technology for each SST identified in the SST Liquids Report." Each of the nine selected technologies were assessed for applicability to the types of waste found in the single-shell tanks, i.e., supernatant, saltcake, sludge, and combinations of the three. The screening process used established evaluation criteria to systematically rank and rate each technology against specific functions, criteria, and requirements. The technologies were assessed for removal of supernatant or interstitial liquids. This assessment meets the Item 2 deliverable of the milestone on a waste-type basis encompassing all single-shell tanks. An air recirculation with interstitial liquid dispersion system is preferred to remove drainable liquid from the SSTs. Air recirculation with condensate recovery is the preferred forced-air system since consistent warm, dry, air is more effective than ambient air in evaporating liquids.

HFFACO, Milestone M-045-93, requires "… a proposed sequence for removing drainable liquids from the SSTs identified in the SST Liquids Report." System Plan 8 ultimately describes the current proposed sequence for removing any waste, including drainable liquids, from single-shell tanks which meets the HFFACO, Milestone-045-93, Item 3, deliverable.

6.0 REFERENCES

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement*, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

HNF-EP-0182, 2020, *Waste Tank Summary Report for Month Ending December 31, 2019*, Rev. 384, Washington River Protection Solutions LLC, Richland, Washington.

ORP-11242, 2017, *River Protection Project System Plan*, Rev. 8, U.S. Department of Energy, Office of River Protection, Richland, Washington.

RPP-13033, 2019, *Tank Farms Documented Safety Analysis*, Rev. 7P, Washington River Protection Solutions LLC, Richland, Washington.

RPP-40149-VOL2, 2019, *Integrated Waste Feed Delivery Plan: Volume 2 – Campaign Plan*, Rev. 5A, Washington River Protection Solutions LLC, Richland, Washington.

RPP-PLAN-57554, 2014, *Portable Exhauster Usage Plan for Evaporation of Supernatant Liquid in Selected Single-Shell Tanks*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-PLAN-63778, 2020, *Multi-Year Operating Plan (MYOP)*, Rev. 1, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-59470, 2018, *TOPSim V3.0 Model Requirements*, Rev. 2A, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-60305, 2019, *Single-Shell Tank Updated Drainable Interstitial Liquid Volumes – 2017*, Rev. 1, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-61929, 2019, *Evaporation of Water from Single-Shell Tanks using Active Ventilation*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

APPENDIX A

LIQUID RETRIEVAL TECHNOLOGY EVALUATION

Appendix A – Liquid Removal Technology Evaluation

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A1.0 PURPOSE

Hanford Federal Facility Agreement and Consent Order (HFFACO), Milestone M-045-93, Item 1, requires "…a description and analysis of each alternative method and technology for removing drainable liquids from the SSTs." This appendix documents the technologies considered, and the process used, to select the technologies which were further evaluated.

A2.0 BACKGROUND

The radioactive and chemical process waste contained in the single-shell tanks (SSTs) exists in one of three tank waste forms: supernatant, saltcake, or sludge. Seven combinations of tank waste forms appear in the SSTs:

- supernatant;
- saltcake;
- sludge;
- supernatant and saltcake;
- supernatant and sludge;
- saltcake and sludge; and
- supernatant, saltcake, and sludge.

The following definitions were obtained from the HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2019*, glossary:

- Supernatant is the liquid above the solids or in large liquid pools in the SSTs.

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For the purposes of this report, the following terms are used:

- Drainable liquid is defined as the combination of drainable interstitial liquid and supernatant.

- A saltwell, or saltwell screen, is a stilling well into which interstitial liquid drains. The saltwell provides a drainable interstitial liquid reservoir from which the drainable interstitial liquid is pumped.

- Condensate is the liquid which is condensed from an airstream. The condensate is condensed from the airstream by reducing the temperature of the gases in the airstream.

- Saltwell liquor is defined as the saturated liquid contained in the SSTs in the form of supernatant or drainable interstitial liquid.

A3.0 METHODOLOGY

The first phase in the technology evaluation identified applicable technologies. This step considered applications across the U.S. Department of Energy (DOE) complex as well as national and international commercial applications. A brainstorming session was held to identify additional technologies. Attendees included current and former Hanford engineers with SST drainable liquid removal experience. The results of the technology search and brainstorming session were compiled into the preliminary list of technologies represented within Section A4.1 through Section A4.9.

The technologies identified in Sections A4.1 through A4.9 were ranked in a multi-attribute decision analysis. The screening process used the evaluation criteria discussed in Section A5.0 to systematically rank and rate each technology against specific functions, criteria, and requirements. During the screening each technology was scored twice. The first assessment considered the technology for interstitial liquid removal applications. The second assessment considered the technology for supernatant removal applications. In each ranking, the two technologies with the highest scores were further considered.

Final selection of an SST drainable liquid removal technology was based on how effective the technologies were against the seven tank waste forms.

A4.0 TECHNOLOGIES CONSIDERED

Nine technologies were considered during the technology evaluation. Until 2004, drainable liquid removal efforts at the Hanford tank farms used a process referred to as Saltwell Pumping. RPP-PLAN-57554, *Portable Exhauster Usage Plan for Evaporation of Supernatant Liquid in Selected Single-Shell Tanks*, provides a plan for reducing supernatant by evaporation using active ventilation. Saltwell pumping and evaporation by active ventilation were therefore included in this evaluation.

Two technologies identified in the brainstorming session were included in the ranking process. One technology is the use of an absorbent to remove supernatant. The second technology from the session is an in-riser evaporator.

The remaining five technologies were derived from the DOE complex, commercial applications, and combinations of the various technologies that provided unique advantages.

A4.1 TECHNOLOGY 1: ENHANCED SUPERNATANT PUMPING SYSTEM

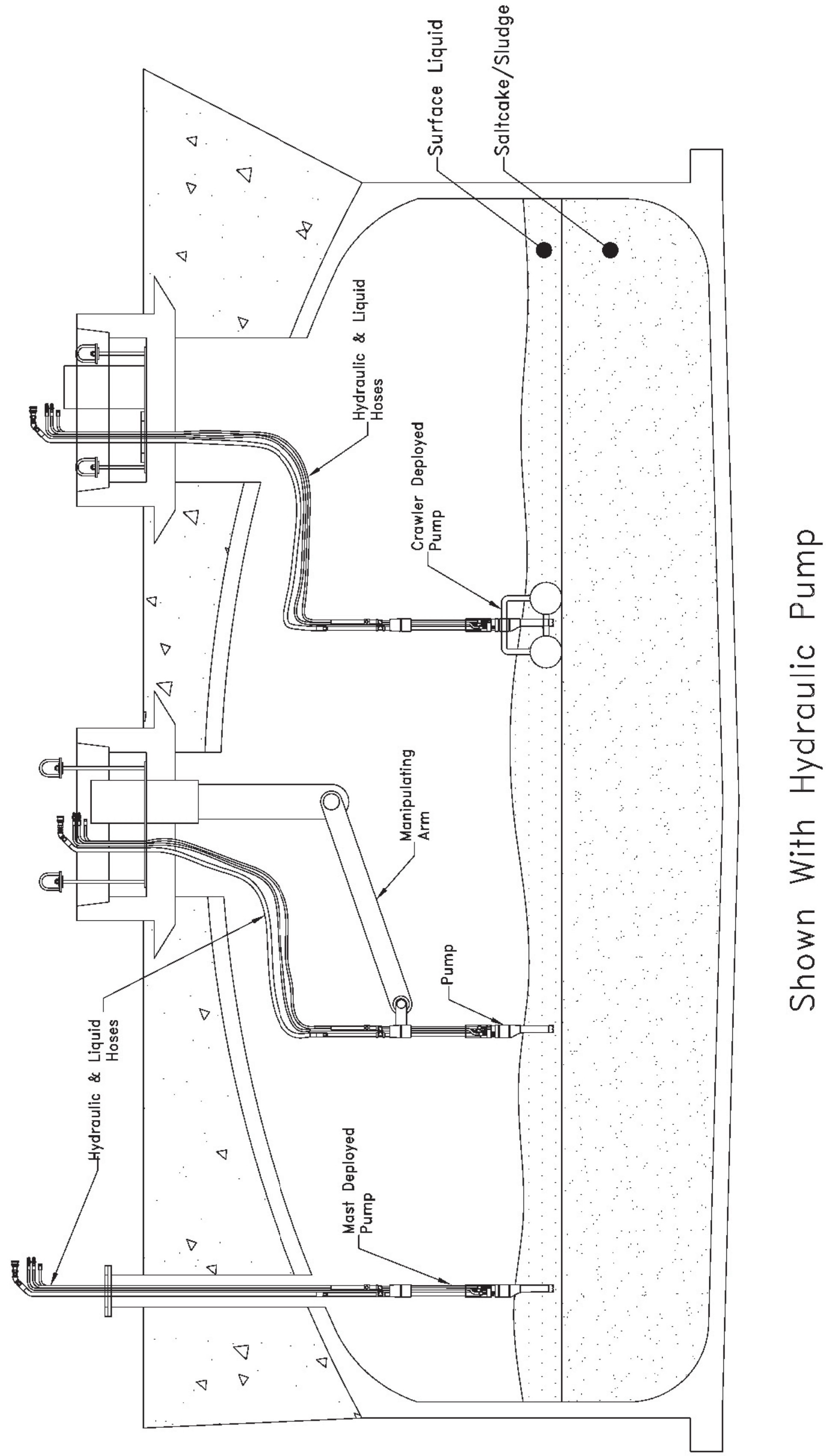
This technology involves a pump being lowered to the supernatant pool. There are three options for installation of the pump depending on the location of the supernatant pool. The pump could be installed on a mast if the supernatant pool is directly below a riser. If the supernatant pool is not below a riser, the pump could be installed on a robotic arm or surface crawler which would transport the pump to the correct location on the tank waste surface. For tanks with multiple supernatant pools, a robotic arm or crawler deployment would permit moving the pump between pools. Figure A4-1 is a high-level depiction of an enhanced supernatant pumping system.

Supernatant removal efforts in the past have been limited by the amount of liquid required to maintain the pump inlet submerged. If necessary, high-pressure water nozzles could create a shallow well in the solid waste surface to ensure the pump inlet is submerged. A low draw-down pump design would be used to minimize the amount of supernatant that would remain in the tank at the end of the removal activity.

Supernatant pumping was successfully deployed in the Hanford tank farms in the past. Operation of the system would be consistent with the current operations described in RPP-13033, *Tank Farms Documented Safety Analysis*. The mast-mounted pump has an advantage in that the contours of the tank waste surface would not hinder the technology's ability to remove the supernatant. The crawler and arm-mounted pumps can be used for multiple supernatant pools within the same tank. Suitable pumps for this application include progressive cavity pumps, diaphragm pumps, jet pumps, bladder pumps, and multi-stage turbine pumps. Some of the listed pump technology is capable of flow rates in excess of 20 gallons per minute. Flow rates of this magnitude would empty the pools in hours rather than days.

There are at least three significant disadvantages to supernatant pumping technology. Supernatant pumping does not remove drainable interstitial liquid. In order to ensure that the supernatant pools not located beneath the deployment riser may be reached, a crawler or robotic arm design is needed. Although crawlers and robotic arms have been deployed in the past, this is a new application and prototype testing is anticipated. Additionally, a saltwell liquor transportation system to an appropriate double-shell waste storage tank is required. The saltwell liquor transportation system could consist of items such as shielded hose-in-hose transfer lines (HIHTL), shielded double-contained, above-ground catch tanks, and shielded tanker trucks. Current operations as described in RPP-13033 require a full-time crew during waste transfer evolutions.

Figure A4-1. Technology 1 – Enhanced Supernatant Pumping System.



A4.2 TECHNOLOGY 2: SINGLE-PASS VENTILATION SYSTEM

In a single-pass ventilation system, shown in Figure A4-2, ambient air enters the tank via an inlet assembly where evaporation from the supernatant increases the humidity in the air. A fan pulls the air through a high efficiency particulate air filter prior to release via a stack to the surrounding environment. These emissions are monitored for radioactive emissions. Any condensation is collected and returned to the tank consistent with the current operations described in RPP-13033. A single-pass ventilation system would not require a condensate transportation system as the condensate drains back to the SST. Tank 241-T-111 used a single-pass ventilation system for supernatant reduction between July 2015 and April 2019 as documented in RPP-RPT-61929, *Evaporation of Water from Single-Shell Tanks using Active Ventilation*.

Single-pass ventilation is a proven technology that is used across the Hanford tank farms. Although not used for waste minimization, single-pass ventilation systems are used in the six double-shell tank farms. Single-pass ventilation systems were also deployed to support SST retrieval.

Using single-pass ventilation systems to reduce supernatant is a simple evolution that does not require condensate storage or processing. This technology is a passive supernatant reduction technique in that it does not disturb the waste. No mechanical equipment would be needed in the tank. The single-pass ventilation system supernatant reduction capability could be enhanced using riser extensions on the air inlet riser and outlet risers. These extensions would emit and collect the air near the waste surface and maximize the supernatant reduction potential.

The effectiveness of single-pass ventilation systems in reducing drainable interstitial liquid is not known. There is no mechanism in this technology to expose the drainable interstitial liquid to the tank waste surface.

RPP-RPT-61929 predicts a supernatant reduction rate of 6 gallons per day per 100 standard cubic feet per minute of exhaust flow. This prediction is based on data from tanks with a 100% supernatant surface. Therefore, this supernatant reduction rate cannot be applied to 100-Series SSTs with less than 2,700 gallons of supernatant or 200-Series SSTs with less than 200 gallons of supernatant. Additional analysis and testing are necessary to determine a single-pass ventilation supernatant reduction rate that would apply to SSTs with less than 100% supernatant level surface.

As discussed in RPP-RPT-61929, the Tank 241-T-111 air operating permit for a single-pass ventilation system used for supernatant reduction was suspended after four years. The concerns that caused the permit to be suspended must be addressed before additional single-pass ventilation systems used for supernatant reduction could be deployed.

Current operations as described in RPP-13033 require periodic maintenance and routine surveillances of a single-pass ventilation system. A full-time work crew is not required for single-pass ventilation system operation.

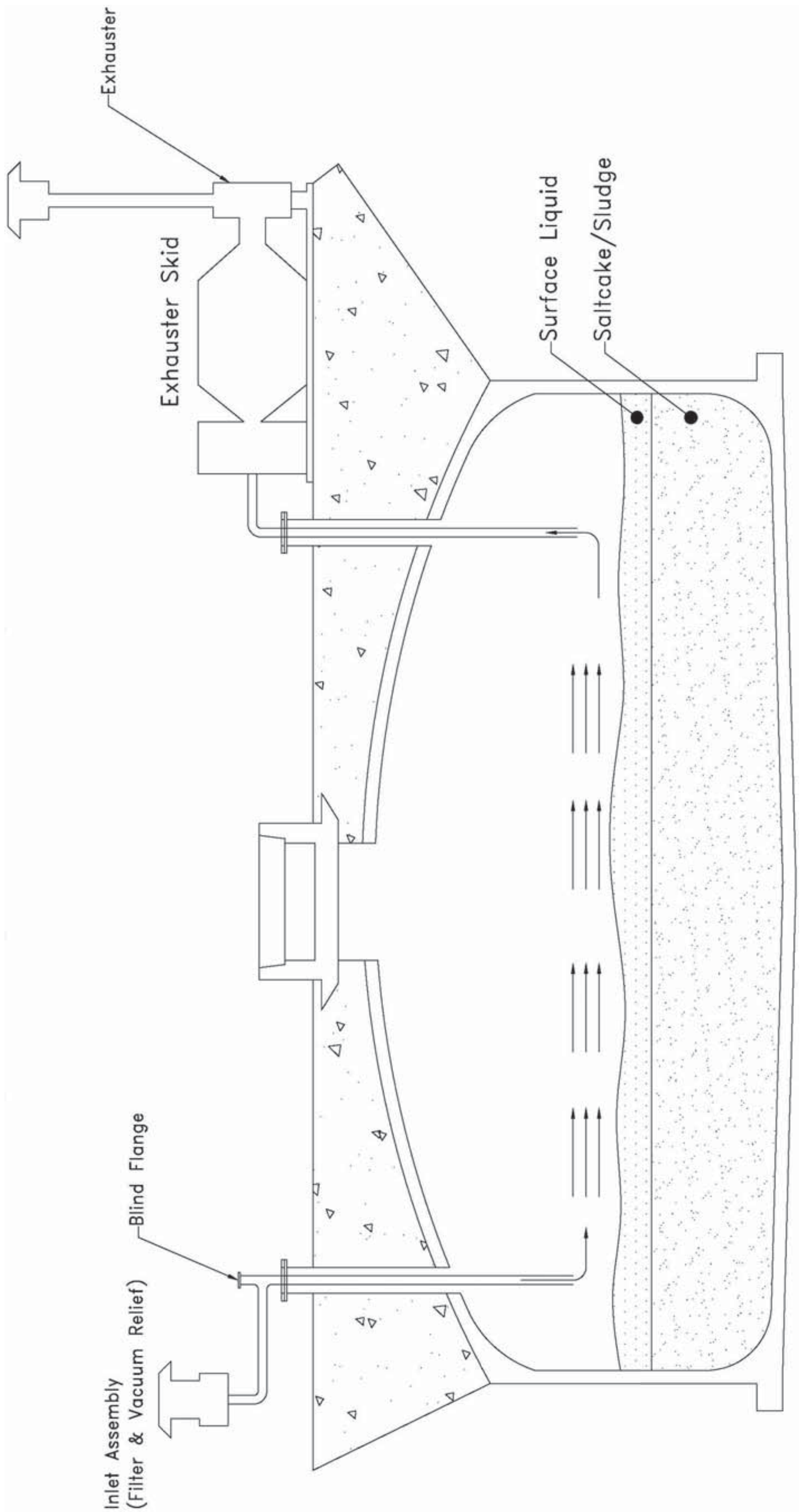


Figure A4-2. Technology 2 – Single-Pass Ventilation System.

A4.3 TECHNOLOGY 3: AIR RECIRCULATION WITH CONDENSATE RECOVERY

An air recirculation with condensate recovery system, depicted in Figure A4-3, is a novel application of the single-pass ventilation system. The air leaving the SST travels first through a regenerating desiccant system to dry the air and then through a heater. The amount of vapor an airstream can carry increases as the air temperature increases. Warm, dry, air is returned to the tank where evaporation from the supernatant increases the humidity in the air and the cycle begins again. The supernatant reduction capability could be enhanced using riser extensions on the air inlet riser and outlet risers. These extensions would emit and collect the air near the waste surface and maximize the supernatant reduction potential.

The necessary equipment within the air recirculation loop would be a fan, a regenerating desiccant system to dry the air, and a reheat coil to raise the airstream temperature. The airstream is not released to the environment, therefore a high efficiency particulate air filter and monitoring for radioactive emissions are not required for operation. The passive ventilation system in place on the tank would remain open consistent with the current operations described in RPP-13033. Condensate would be collected for disposal.

The effectiveness of air recirculation with condensate recovery systems in reducing drainable interstitial liquid is not known. There is no mechanism in this technology to expose the drainable interstitial liquid to the tank waste surface.

Report RPP-RPT-61929 predicts a supernatant reduction rate of 6 gallons per day per 100 standard cubic feet per minute of exhaust flow for a single-pass ventilation system using ambient air. The air recirculation system utilizes warm, dry, air and should reduce the supernatant volume at a faster rate than a single-pass ventilation system at the same flow rates. Additional analysis and testing are necessary to predict the air recirculation supernatant reduction rates.

As discussed in RPP-RPT-61929, the Tank 241-T-111 air operating permit for a single-pass ventilation system used for supernatant reduction was suspended after four years. Since this system does not generate atmospheric releases an operating permit may not be needed.

Although not addressed in RPP-13033, the operating requirements for an air recirculation with condensate recovery system is anticipated to be like the requirements for a single-pass ventilation system. A full-time work crew is not required for single-pass ventilation system operation. A condensate transportation system to an appropriate disposal location or double-shell waste storage tank is required. The condensate transportation system could consist of items such as double-contained above-ground totes or catch tanks and tanker trucks. A complete crew is anticipated for condensate transport to the disposal location.

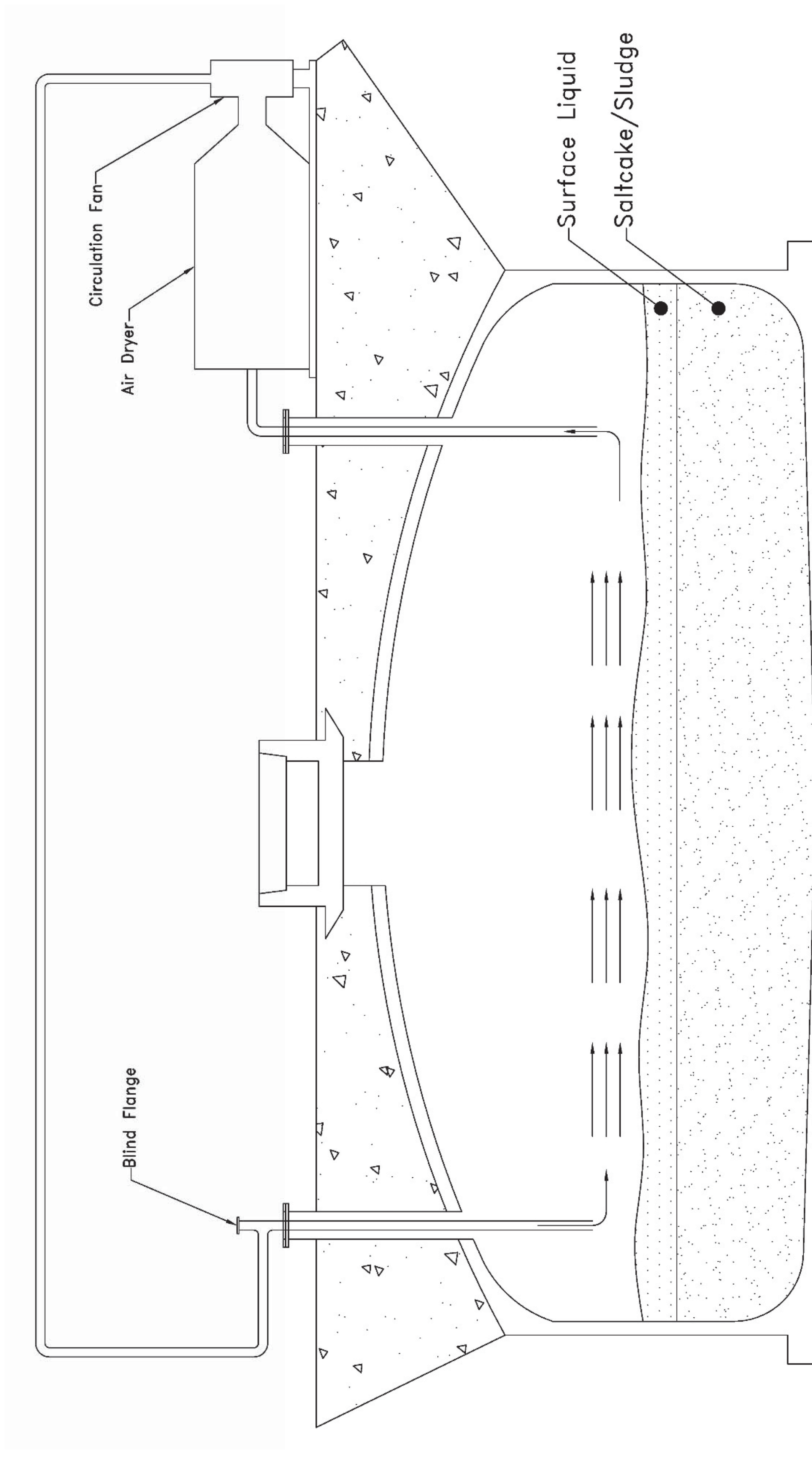


Figure A4-3. Technology 3 – Air Recirculation with Condensate Recovery.

A4.4 TECHNOLOGY 4: PERMEABLE MEDIA CONVEYOR

Technology 4 describes a permeable media conveyor system process which targets drainable interstitial liquid. This system is shown in Figure A4-4. A new saltwell screen would be installed in the tank to allow interstitial liquid to accumulate in an accessible location. The permeable media conveyor would remove the saltwell liquor from within the saltwell screen. A revolving conveyor belt fabricated from permeable, absorbing material would be attached to a modified mast and installed in the saltwell screen. Saltwell liquor would be removed from the conveyor belt by a mangle or wringer assembly at the top of the riser. The saltwell liquor would be accumulated in a containment vessel integrated into the top of the riser.

The saltwell liquor removal rate could be adjusted by varying the conveyor speed. Adjustable removal rates help compensate for the anticipated low percolation rates approaching 0.05 gallons per minute.

This is a novel technology for the Hanford site inspired by computer numerical control (CNC) machine coolant oil skimmers and modified to a conceptualized waste retrieval technology. Considerable development, including absorbent material testing as well as prototype and scale testing of the system, would be required prior to deployment. Systems of this type are prone to jamming. Jammed conveyors or rollers would be difficult to resolve. It is not possible to predict recovery rates at this time.

A saltwell liquor transportation system to an appropriate double-shell waste storage tank is required in conjunction with this technology. The saltwell liquor transportation system could consist of items such as HIHTL, shielded double-contained above-ground catch tanks, and shielded tanker trucks. Current operations as described in RPP-13033 require a full-time crew during waste transfer evolutions.

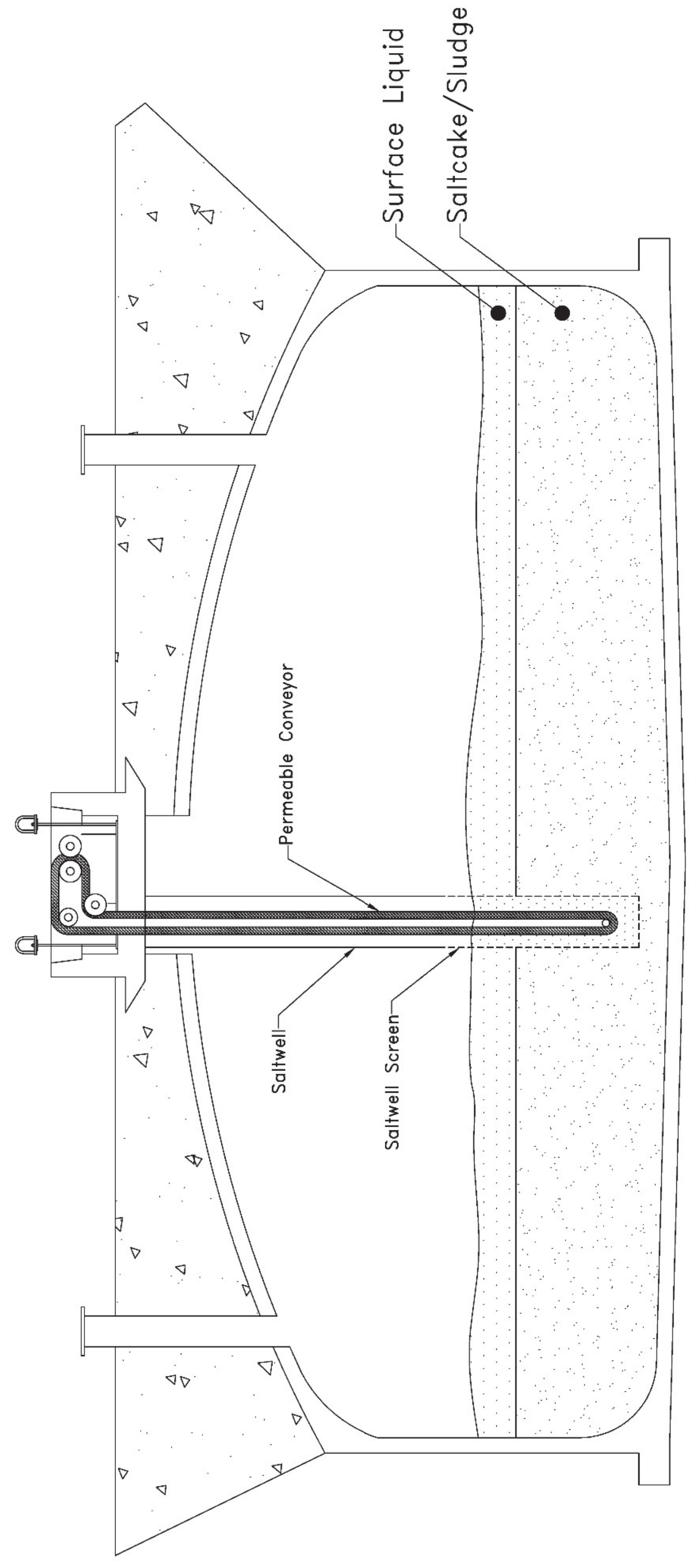


Figure A4-4. Technology 4 – Permeable Media Conveyor.

A4.5 TECHNOLOGY 5: ENHANCED SALTWELL PUMPING

Saltwell pumping, also called jet pumping, is the technology that was used to remove drainable interstitial liquid during the SST interim stabilization activities. Pump technology has advanced such that multiple pump options exist which are suitable for this application. The process requires a saltwell screen be installed in a riser to allow drainable interstitial liquid to percolate into an accessible location. A pump lowered into the saltwell screen raises the saltwell liquor to grade for transportation to a suitable double-shell waste storage tank. Any supernatant in the area of the saltwell screen flows into the well and is removed.

A possible enhancement to the SST interim stabilization process involves the use of multiple saltwell screens in an SST. It is possible that multiple saltwell screens could reduce the time required to recover the drainable interstitial liquid. This concept is shown in Figure A4-5. Additional analysis is required to determine if multiple saltwell screens would be effective.

New saltwell screens are assumed to be required as the existing screens have been in the tanks for a minimum of 15 years. Before a saltwell screen can be installed, a water lance is used to create a hole in the waste solids. How far into the solids the saltwell screen is installed depends on how effective the water lancing process is at creating the hole. In general, saltcake is water soluble and full depth saltwell screens are feasible. Sludge solids tend to be resistant to water lancing and, therefore, full depth saltwell screens installed in SSTs with deep sludge are less common.

One challenge encountered during SST interim stabilization activities was associated with the low percolation rates encountered in sludges and at the later stages of saltwell pumping in saltcake. Percolation flow rates lower than 0.05 gallons per minute were common. The lowest flow rate from the jet pump used in the SST interim stabilization saltwell pumping program was 0.05 gallons per minute. The jet pumps also required water additions in order to start the pump as they were incapable of maintaining their prime after they were stopped. A progressive cavity pump, such as one in the hydraulic pump design by AGI Engineering, is suitable for the application. There are multiple other pump options which could be used, including air operated diaphragm pumps and bladder pumps.

A second challenge encountered during saltwell pumping was the plugging of the saltwell screen. Saltwell liquor is a saturated solution which leaves hardened saltcake on surfaces and clogs the screen, further reducing the percolation rate into the saltwell screen. Saltcake dissolves in hot water or steam; however, the additional water additions affect retrieval rates.

A saltwell liquor transportation system to an appropriate double-shell waste storage tank is required. The saltwell liquor transportation system could consist of items such as HIHTL, shielded double-contained, above-ground, catch tanks, and shielded tanker trucks. Current operations as described in RPP-13033 require a full-time crew during waste transfer evolutions.

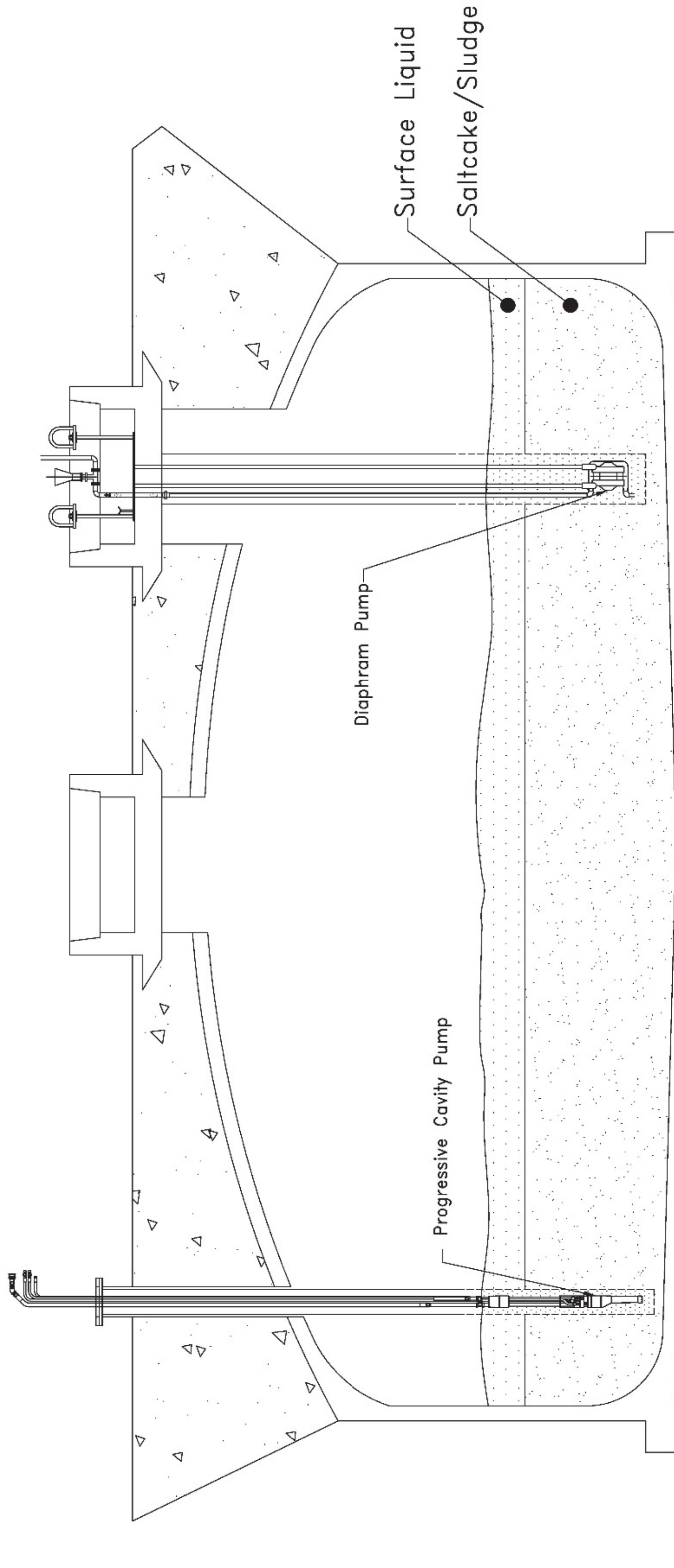


Figure A4-5. Technology 5 – Enhanced Saltwell Pumping.

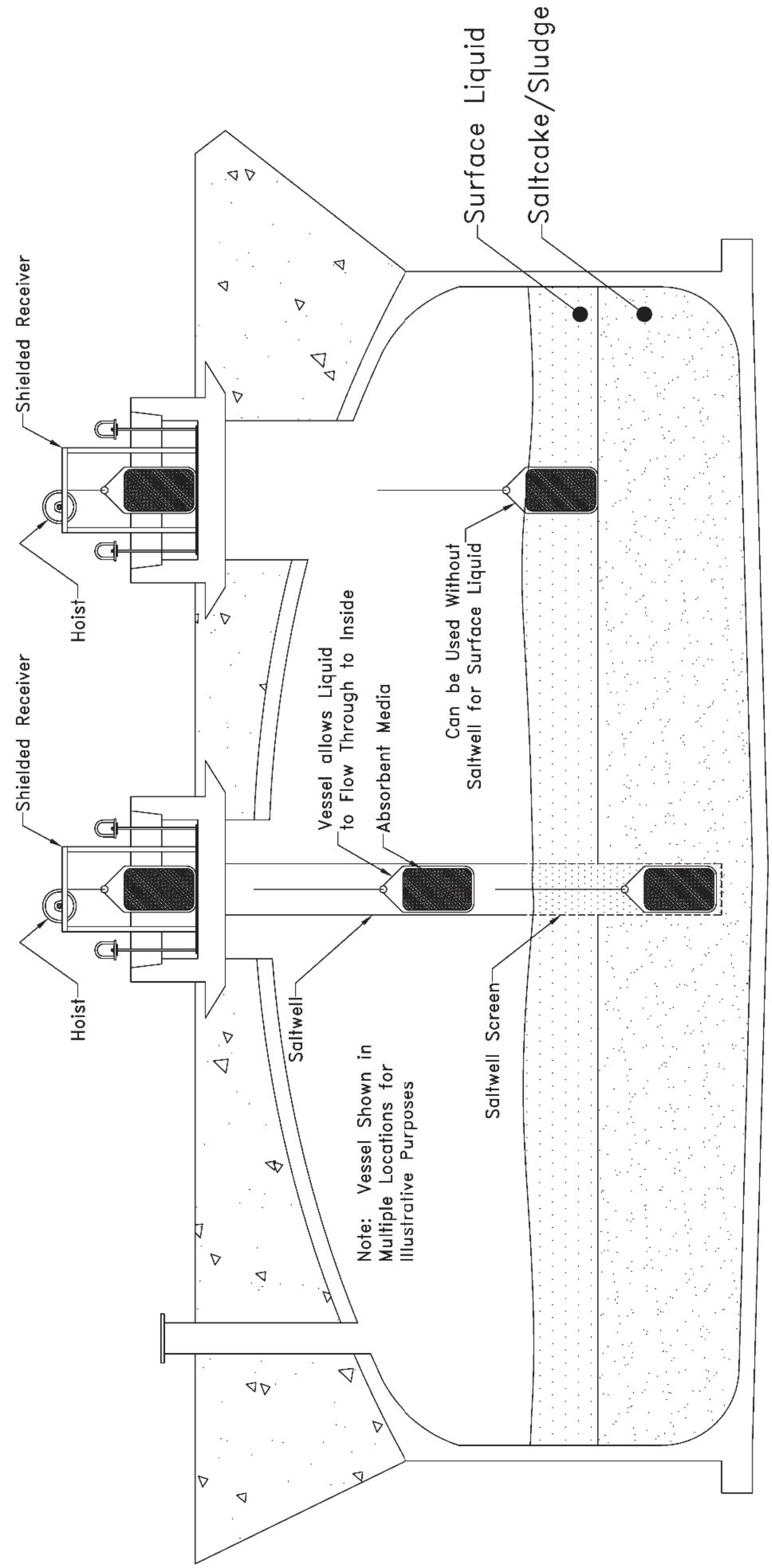
A4.6 TECHNOLOGY 6: SINGLE-USE ABSORPTION MEDIA CARTRIDGE

Single-use absorption media cartridge is a novel technology. As shown in Figure A4-6, an absorption media cartridge would be lowered via a mast down to the supernatant or into an installed saltwell screen. Once the media had reached saturation, the cartridge would be retracted into a shielded receiver above grade and packaged for disposal. A new cartridge would be installed and the process repeated until the target drainable interstitial liquid level is achieved. Additional absorbent material could be suspended from the absorption media cartridges to act as wicking material. The wicking material would be replaced with the cartridges.

Single-use absorption media cartridge technology would not require liquid waste transfer supporting infrastructure. The technology would require routine removal of long-length contaminated equipment to remove the cartridge and wicking material. The used cartridges and wicking material would be disposed of as solid waste.

Significant material testing would be required prior to selection of the absorbent and wicking material. Design for the wicking material deployment mechanism and the media cartridge would be followed by prototype and mock-up testing prior to in-tank deployment. Recovery rates cannot be predicted at this time.

Figure A4-6. Technology 6 – Single Use Absorption Media Cartridge.



A4.7 TECHNOLOGY 7: IN-RISER EVAPORATOR

The proposed in-riser evaporator technology would combine the pumping methodologies described in previous evaluations with a small-scale evaporator. As envisioned, the process would pump supernatant or drainable interstitial liquid from a saltwell screen into a small-scale evaporator crystallizer contained within the SST. A possible configuration is included in Figure A4-7. The pumped liquid would be recirculated within the evaporator until the desired specific gravity is reached. Once the desired specific gravity is achieved, the concentrated liquid waste would be returned to the solids surface. Condensate from the process would be collected in double-contained, above-ground, catch tanks or tanker trucks for transport to an appropriate disposal location or double-shell waste storage tank. The condensate transportation system could consist of items such as double-contained above-ground totes or catch tanks and tanker trucks. A complete crew is anticipated for operation of the evaporator as well as for condensate transport to the disposal location.

Although similar evaporators have been proposed in the past, there are no riser sized evaporators used in the Hanford tank farms. Considerable design development, prototype testing, and scale testing of the system would be required prior to deployment. Deployment of in-riser evaporator technology is expected to encounter design challenges. The recovery rates associated with this technology cannot be predicted at this time.

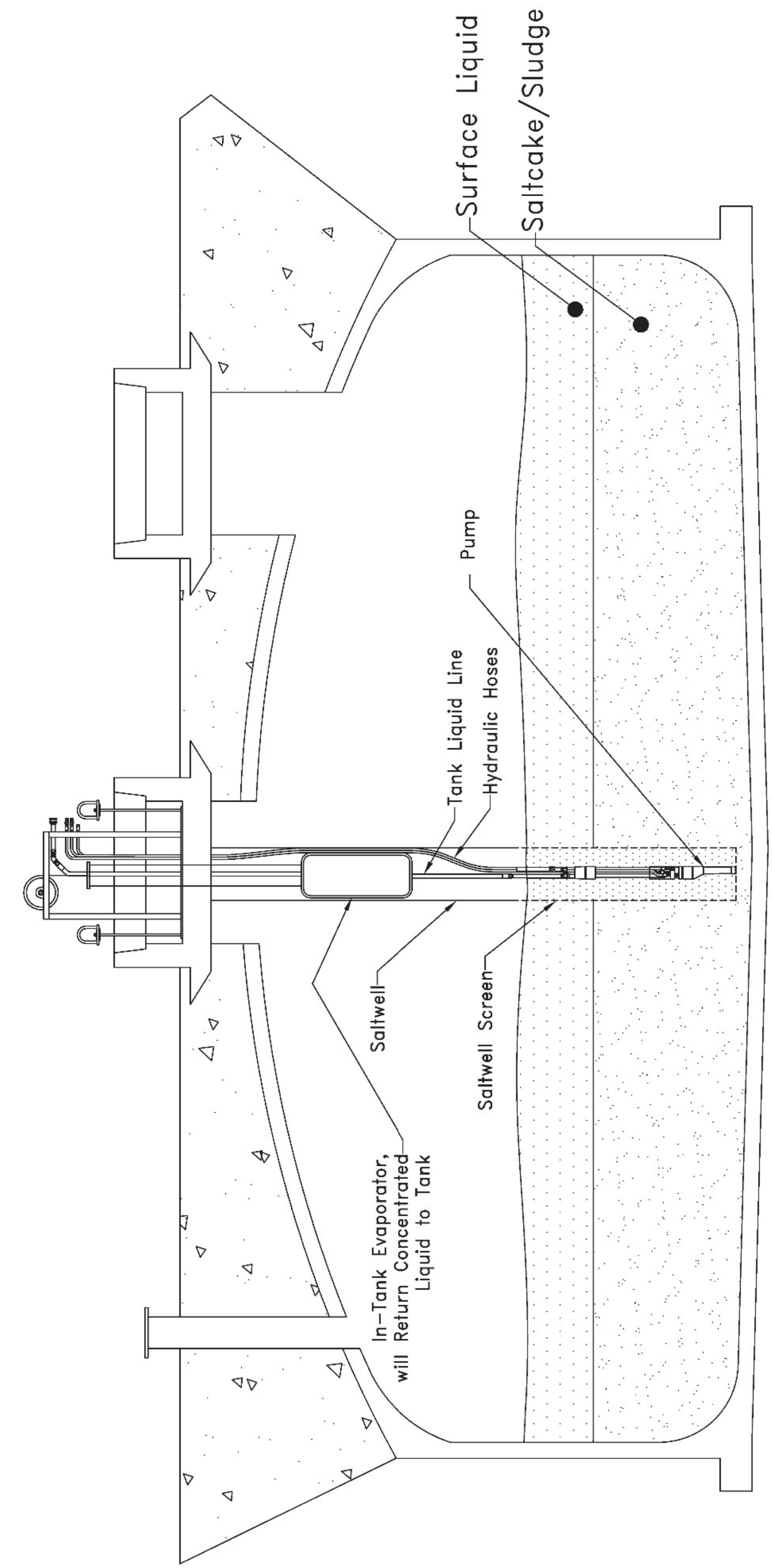


Figure A4-7. Technology 7 – In-Riser Evaporator.

A4.8 TECHNOLOGY 8: VENTILATION OR RECIRCULATION WITH WASTE SOLIDS SURFACE DISTURBANCE

A single-pass ventilation system or air recirculation with condensate recovery system is effective in drainable liquid volume reduction for supernatant. Drainable interstitial liquid is not exposed to the evaporative effects of the moving air. One method to expose drainable interstitial liquid to the moving air, as shown in Figure A4-8, is by disturbing the waste solids surface. An in-tank crawler equipped with tools designed to agitate the waste surface could be introduced to the SST via a riser. The agitation tool may resemble a tiller, aerator, or subsoiler. Agitating the waste surface allows moving air to reach more of the drainable interstitial liquid. Combining the in-tank crawler with either the single-pass ventilation system or air recirculation with condensate recovery system increases the volume of drainable liquid removed from the SST compared to the single-pass ventilation system or air recirculation with condensate recovery system alone.

Report RPP-RPT-61929 predicts a supernatant reduction rate of 6 gallons per day per 100 standard cubic feet per minute of exhaust flow. This prediction is based on data from tanks with a 100% supernatant surface. Therefore, this drainable liquid reduction rate cannot be used to predict recovery rates from using the waste solids disturbance technology.

The drainable liquid removed using this technology is limited to drainable liquid that is at, or near, surface. Although the actual depth of material disturbed cannot be determined until after design and testing, it is anticipated that the technology will disturb no deeper than 6 inches of waste. If an SSTs drainable interstitial liquid level is below the waste surface disturbance depth, this technology does not remove more drainable liquid than a single-pass ventilation system or air recirculation with condensate recovery system.

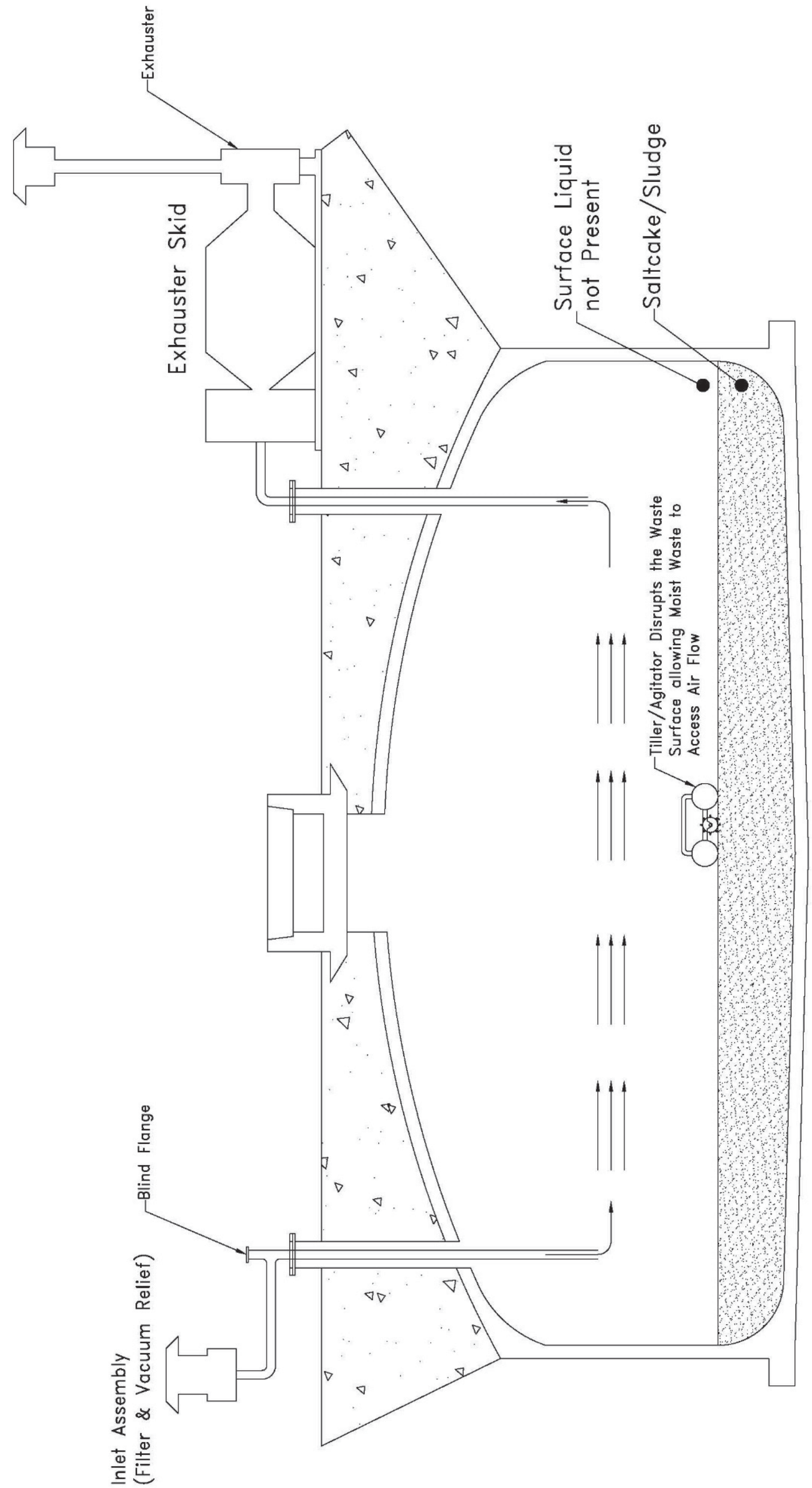


Figure A4-8. Technology 8 –Ventilation or Recirculation with Waste Solids Surface Disturbance.

A4.9 TECHNOLOGY 9: VENTILATION OR RECIRCULATION WITH INTERSTITIAL LIQUID DISPERSION

A single-pass ventilation system or air recirculation with condensate recovery system is effective in reducing supernatant volume. Drainable interstitial liquid is not exposed to the evaporative effects of the moving air. One method to expose drainable interstitial liquid to the moving air is by pumping the drainable interstitial liquid onto the waste surface. The proposed technology is a novel combination of two technologies proven effective in the Hanford tank farms. Figure A4-9 shows a possible configuration.

A submersible pump was installed in Tank 241-AN-106 to agitate the supernatant in the tank. The pump intake was near the double-shell tank solids level, well below the waste surface. Supernatant was discharged above the waste surface where it fell back to the supernatant pool. Hanford Tank Farms personnel noticed that the agitation process coincided with indications of increased condensate in the air stream. The 241-AN Tank Farm double-shell tanks have active ventilation.

Plan RPP-PLAN-57554 discusses historical evaporation rates. Information associated with Tank 241-C-107 is included in the plan. Plan RPP-PLAN-57554 states that higher evaporation rates were seen in Tank 241-C-107 during active retrieval operations.

As previously discussed, Tank 241-T-111 used a single-pass ventilation system for supernatant reduction between July 2015 and April 2019. Continued operation of this system was suspended as efforts to obtain an air operating permit for the emissions of toxic air pollutants from Tank 241-T-111 were put on hold until the Washington State Department of Ecology concerns over the location of the ambient air boundary are resolved.

Combining these two proven technologies is a novel approach to reducing the drainable liquid volumes in the SSTs. A pump installed in a saltwell screen could discharge the drainable interstitial liquid to the solid waste surface, exposing the drainable interstitial liquid to the moving air. As the pump does not need to transport the drainable interstitial liquid out of the SST, the pump is anticipated to be smaller than those used for above ground transfers. The combination of a single-pass ventilation system or air recirculation with condensate recovery system and a pump with waste surface discharge would be effective at reducing both supernatant volumes and drainable interstitial liquid volumes.

It is possible that multiple saltwell screens and interstitial liquid dispersion pumps could reduce the time required to recover the drainable interstitial liquid. Additional analysis is required to determine if multiple saltwell screens would be effective.

The system limitations, required supporting systems, and operating requirements for the combined system are expected to be similar to those described for the single-pass ventilation system and air recirculation with condensate recovery system in Sections A4.2 and A4.3, respectively. As the interstitial liquid dispersion pump does not move waste outside of the tank, current operations as described in RPP-13033 suggest that a full-time work crew would not be required to operate the interstitial liquid dispersion pump.

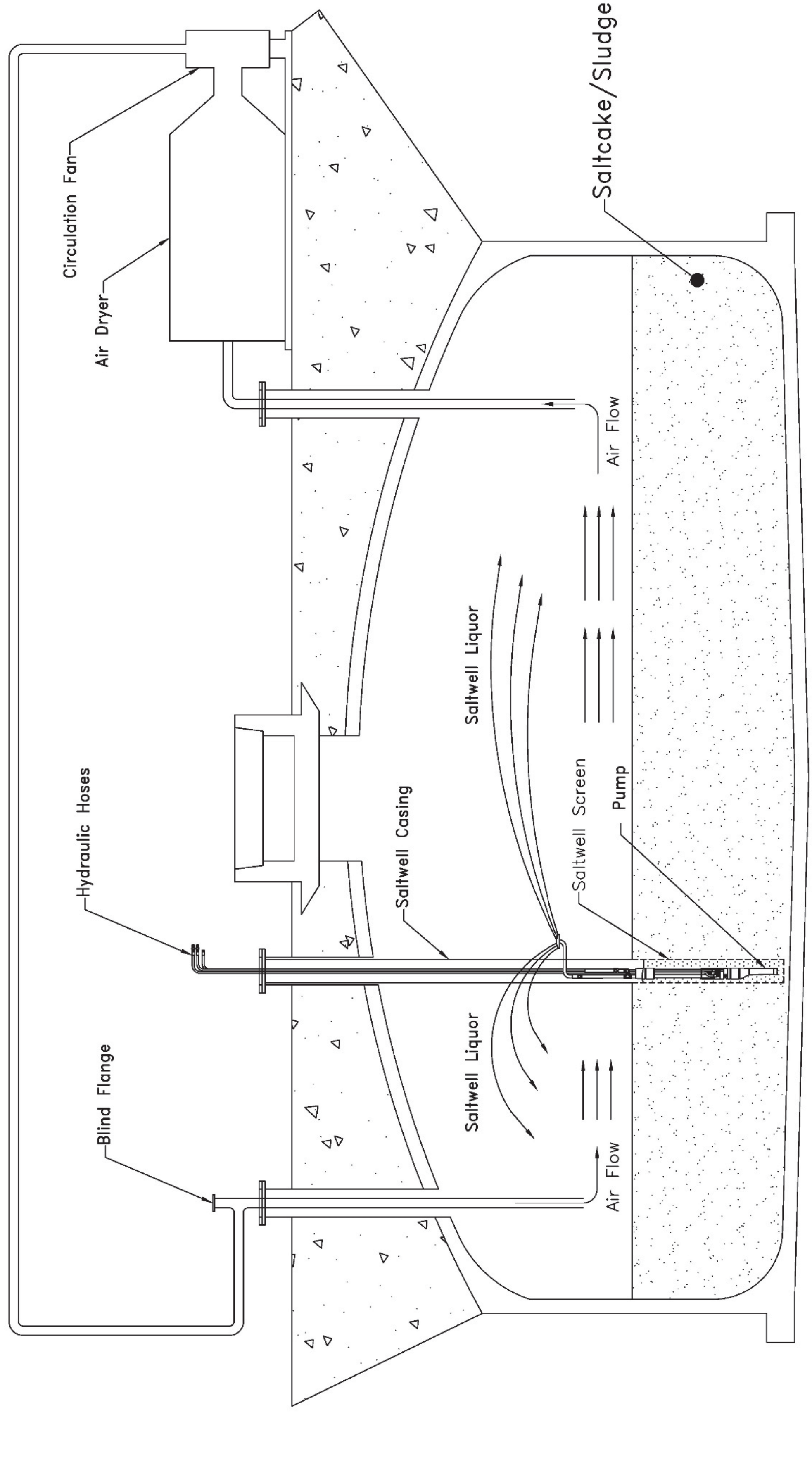


Figure A4-9. Technology 9 – Ventilation or Recirculation with Interstitial Liquid Dispersion.

A5.0 MULTI-ATTRIBUTE DECISION ANALYSIS CRITERIA

The technologies identified in Sections A4.1 through A4.9 were ranked in a multi-attribute decision analysis. The screening process used evaluation criteria to systematically rank and rate each technology against specific functions, criteria, and requirements. Selection of the criteria was performed prior to the analysis as was approval of the criteria by the activity sponsor. Four evaluation criteria were used in the decision analysis. A raw score was given to each technology. Each team member provided a qualitative score for each criterion. The raw score was obtained by summing the scores provided for the criterion. The raw scores were normalized using the criterion weighting discussed below. The highest score a given technology could receive is 60 points and the lowest possible score is 0 points.

Likelihood of Success – Criterion Weight: 35%

Likelihood of success captured the confidence that the technology would retrieve the targeted liquid. The technologies which the team believed would retrieve the highest quantities of waste were ranked highest. Likelihood of success was the highest weighted criterion reflecting the emphasis on removing the drainable liquids from the SSTs.

Design Maturity – Criterion Weight: 25%

Design maturity acknowledges the design, cost, and schedule challenges associated with novel technologies. A design which utilized technologies or equipment that had been deployed in the Hanford tank farms or in a nuclear waste environment was ranked higher than those technologies which would require significant prototype testing. The criterion weight of 25% reflects the importance of rapid, cost-effective, deployment.

As Low As Reasonably Achievable (ALARA) – Criterion Weight: 20%

The As Low As Reasonably Achievable (ALARA) criterion addresses the chemical, radiological, and mechanical hazards associated with materials being transported and the nuclear safety implications of the technology. Technologies that were passive devices and did not require transportation of materials scored higher than technologies which required work crews for operation or required condensate or saltwell liquor transportation. Those technologies which required condensate disposal ranked higher than those that required saltwell liquor transfers.

Reliability and Complexity – Criterion Weight: 20%

Reliability and complexity considers the importance of technologies which are simple in terms of design, field implementation, and liquid retrieval operations. Hanford site and commercial experience finds that technologies which are complex in terms of design, fabrication, construction, and operation are, in general, prone to reliability issues. A technology which was perceived to be simple for design, deployment, and operation scored higher than those perceived to be complex. The criterion also addressed availability of needed utilities for implementation. A technology which required a single utility such as electricity scored higher than those requiring multiple utilities.

A6.0 MULTI-ATTRIBUTE DECISION ANALYSIS RESULTS

The multi-attribute decision analysis was performed on February 20, 2020. The team assembled for the multi-attribute decision analysis was comprised of personnel with between 10 and 29 years of experience in Hanford tank farms engineering, SST interim stabilization, SST retrieval design, operations, construction, and testing. During the multi-attribute decision analysis each technology was scored twice. The first assessment considered the technology for supernatant removal applications. The second assessment considered the technology for interstitial liquid removal applications. In each analysis, the two technologies with the highest scores were selected for further exploration. The maximum score a technology could receive was 60 points. If a technology was not applicable to the drainable liquid being evaluated, the technology was identified as "Not Applicable." The results of the decision analysis for supernatant removal is presented in Table A6-1. Table A6-2 contains the decision analysis results for drainable interstitial liquid.

Table A6-1. Supernatant Removal Technology Analysis Results.

Technology	Raw Scores				Weighted Total
	Likelihood of Success (35%)	Design Maturity (25%)	ALARA (20%)	Reliability and Complexity (20%)	
Technology 1 – Enhanced Supernatant Pumping System	48	38	20	30	36.30
Technology 2 – Single-Pass Ventilation System	60	60	42	35	51.40
Technology 3 – Air Recirculation with Condensate Recovery	60	43	47	44	49.95
Technology 4 – Permeable Media Conveyor	19	4	19	10	13.45
Technology 5 – Enhanced Saltwell Pumping	20	50	20	45	32.50
Technology 6 – Single-Use Absorption Media Cartridge	9	2	4	18	8.05
Technology 7 – In-Riser Evaporator	21	9	47	12	21.40
Technology 8 – Ventilation or Recirculation with Waste Solids Surface Disturbance	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Technology 9 – Ventilation or Recirculation with Interstitial Liquid Dispersion	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

The top scoring supernatant removal technologies were Technology 2 – Single-Pass Ventilation System and Technology 3 – Air Recirculation with Condensate Recovery. These two technologies scored more than 10 points higher than the next technology. Single-pass ventilation system scored higher in the design maturity criterion while air recirculation with condensate recovery scored higher in ALARA as well as reliability and complexity.

Table A6-2. Drainable Interstitial Liquid Removal Technology Analysis Results.

Technology	Raw Scores				Weighted Total
	Likelihood of Success (35%)	Design Maturity (25%)	ALARA (20%)	Reliability and Complexity (20%)	
Technology 1 – Enhanced Supernatant Pumping System	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Technology 2 – Single-Pass Ventilation System	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Technology 3 – Air Recirculation with Condensate Recovery	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Technology 4 – Permeable Media Conveyor	33	4	19	10	18.35
Technology 5 – Enhanced Saltwell Pumping	55	50	20	45	44.75
Technology 6 – Single-Use Absorption Media Cartridge	29	2	4	18	15.05
Technology 7 – In-Riser Evaporator	33	9	47	12	25.60
Technology 8 – Ventilation or Recirculation with Waste Solids Surface Disturbance	10	23	42	13	20.25
Technology 9 – Ventilation or Recirculation with Interstitial Liquid Dispersion	51	42	42	43	45.35

For drainable interstitial liquid removal, the top scoring technologies were Technology 5 – Enhanced Saltwell Pumping and Technology 9 – Ventilation or Recirculation with Interstitial Liquid Dispersion. These two technologies scored 20 points higher than the next technology. Enhanced saltwell pumping scored higher in the likelihood of success and design maturity criteria while ventilation or recirculation with interstitial liquid dispersion scored higher in ALARA as well as reliability and complexity.

To determine the best technology for both the supernatant and drainable interstitial liquid removal, a matrix was developed to compare the four selected technology applications by tank waste form. The matrix is included as Table A6-3. Single-pass ventilation and air recirculation with condensate recovery are not considered effective for drainable interstitial liquid removal.

Enhanced saltwell pumping is not effective for supernatant removal. Ventilation or recirculation with interstitial liquid dispersion raises drainable interstitial liquid to the waste surface. Once on the waste surface the liquid is exposed to the moving air in the proposed supernatant removal technologies. As such, ventilation or recirculation with interstitial liquid dispersion is effective for both supernatant and drainable interstitial liquid. Based on the information in Table A6-3, ventilation or recirculation with interstitial liquid dispersion is the preferred technology.

Table A6-3. Technology Application by Tank Waste Form.

Tank Waste Form	Technology 2 Single-Pass Ventilation	Technology 3 Air Recirculation with Condensate Recovery	Technology 5 Enhanced Saltwell Pumping	Technology 9 Ventilation or Recirculation with Interstitial Liquid Dispersion
Supernatant	X	X		X
Saltcake			X	X
Sludge			X	X
Supernatant and Saltcake	X	X	X	X
Supernatant and Sludge	X	X	X	X
Saltcake and Sludge			X	X
Supernatant, Saltcake, and Sludge	X	X	X	X

There are two options associated with the preferred technology: single-pass ventilation or air recirculation with condensate recovery. These two supernatant removal technologies were discussed earlier in this appendix. Single-pass ventilation uses ambient air to encourage supernatant evaporation. Air recirculation with condensate recovery uses recirculated warm, dry, air to accomplish the supernatant volume reduction.

By inspection, warm, dry, air is more effective than ambient air for evaporation of liquids. Therefore, air recirculation with interstitial liquid dispersion was determined to be the preferred technology for SST drainable liquid removal.

A7.0 CONCLUSIONS

Nine technologies were considered in this evaluation. Based on the results from a multi-attribute decision analysis shown in Tables A6-1 and A6-2 and the technology applications by tank waste form comparison matrix included in Table A6-3, raising the drainable interstitial liquid to the surface for forced-air evaporation as proposed in Technology 9 is the preferred approach. Air recirculation with condensate recovery is the preferred forced-air system since consistent warm, dry, air is more effective than ambient air in evaporating liquids.

A8.0 REFERENCES

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