U.S. Department of Energy
Hanford Field Office
P.O. Box 550
Richland, Washington 99352

January 16, 2025

25-TWO-0006

Ms. Stephanie Schleif, Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Ms. Schleif:

SUBMITTAL OF RPP-RPT-65234, "241-T-101 ACTIVE VENTILATION PRACTICABILITY EVALUATION," REVISION 0

The U.S. Department of Energy, Hanford Field Office submits RPP-RPT-65234, "241-T-101 Active Ventilation Practicability Evaluation," Revision 0, to the Washington State Department of Ecology for approval.

This submittal was prepared in accordance with the requirements set forth in Addendum to Agreed Order Docket No. 21304, and fulfills the requirement of Section V.C.1, to submit the 241-T-101 active ventilation practicability evaluation and determination, by January 31, 2025.

If you have any questions, please contact me, or you may contact Ricky Bang, Deputy Assistant Manager, Tank Waste Operations, at (509) 376-4151.

Sincerely,

Delmar L. Noyes
Digitally signed by Delmar L. Noyes
Date: 2025.01.16 11:17:40 -08'00'

Delmar L. Noyes, Assistant Manager
Tank Waste Operations

TWO:ENN

Attachment and cc: See page 2

Attachment:
241-T-101 Active Ventilation Practicability Evaluation

cc w/attach:
S. L. Brasher, HMIS
E. J Holbrook, Ecology
L. K. Johnston, Ecology
J. J. Lyon, Ecology
E. A. Rochette, Ecology
M. J. Turner, HMIS
Administrative Record
BNI Correspondence
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cc w/o attach:
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T. G. Beam, WRPS
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A. G. Miskho, WRPS
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B. Rodriguez, CTUIR
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A. Smith, NPT

Attachment
25-TWO-0006

241-T-101 Active Ventilation Practicability Evaluation

(54 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, (WRPS)
Contractor For U.S. Department of Energy, Hanford Field Office

Release Stamp

DATE: Jan 14, 2025 HANFORD RELEASE

1. **Doc No:** RPP-RPT-65234 **Rev.** 00

2. **Title:**
241-T-101 Active Ventilation Practicability Evaluation

3. **Project Number:** ☒N/A

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

5. **USQ Number:** ☒ N/A N/A-9

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type: Approved for Public Release

7. **Approvals**

Title	Name	Signature	Date
Checker	Anderson, John L	*Anderson, John L*	12/23/2024
Clearance Review	Moyer, Heather L	*Moyer, Heather L*	01/14/2025
Document Control Approval	Valadez, Melissa D	*Valadez, Melissa D*	01/14/2025
Environmental Protection	Hamilton, James T	*Hamilton, James T*	12/23/2024
Originator	Brown, Tony N	*Brown, Tony N*	12/23/2024
Other Approver	Mendoza, Ruben E	*Brown, Tony N for Mendoza, Ruben E per telecon*	12/23/2024
Other Approver	Breckenridge, Jolynn K	*Breckenridge, Jolynn K*	12/19/2024
Other Approver	Anderson, Joshua M	*Anderson, Joshua M*	12/18/2024
Process Engineer	Field, Jim G	*Field, Jim G*	12/18/2024
Responsible Manager	Moberg, Timothy P	*Moberg, Timothy P*	12/26/2024

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
241-T-101	241-VT	

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
EDT-884599	00	241-T TANK FARM INTERIM SURFACE BARRIER DESIGN DRAWING INITIAL RELEASE
H-14-100867 SH 002	01	500 CFM PORTABLE EXHAUSTERS B,C,&D PARTS LIST & GEN NOTES
H-14-100867 SH 007	01	500 CFM PORTABLE EXHAUSTERS B,C, & D ASSEMBLY & PIPING PLAN
H-14-100867 SH 008	01	500 CFM PORTABLE EXHAUSTERS B,C, & D DETAILS
H-14-106608 SH 001	04	TANK VACUUM RELIEF AND CONTROL DEVICE
H-14-110122 SH 001	00	241-T POR06 EXAUSTER INSTALLATION ELEVATION
H-2-73059 SH 001	06	PIPING WASTE TANK ISOLATION 241-T-101
H-2-829116 SH 001	04	POR06 PORTABLE EXHAUST SYTEM P & ID
H-2-829116 SH 002	03	500 CFM PORTABLE EXHAUSTERS PIPING & INSTRUMENT DIAGRAM
H-2-829117 SH 003	02	POR06 ELECTRICAL (EDS) PANELBOARD SCHEDULE
HNF-EP-0182	442	Waste Tank Summary Report for Month Ending October 31, 2024
HNF-EP-0182	441	Waste Tank Summary Report for Month Ending September 30, 2024
HNF-SD-RE-TI-178	09A	SINGLE SHELL TANK INTERIM STABILIZATION RECORD
OSD-T-151-00013	11	OPERATING SPECIFICATIONS FOR SINGLE-SHELL WASTE STORAGE TANKS
RPP-11802	04C	ANALYSIS OF RECORD SUMMARY FOR SINGLE-SHELL TANKS
RPP-13033	08T	TANK FARMS DOCUMENTED SAFETY ANALYSIS
RPP-15188	13G	TANK FARMS HAZARD EVALUATION DATABASE REPORT
RPP-57039	41	LOW Quarterly Scan Summary - Q2 - CY24
RPP-ASMT-62935	00	Leak Assessment Report for Tank 241-T-101
RPP-PLAN-57554	00	Portable Exhauster Usage Plan for Evaporation of Supernatant Liquid in Selected Single-Shell Tanks
RPP-PLAN-65643	00	Single-Shell Tank System Leak Response Plan
RPP-RPT-58186	03	Derivation of Best-Basis Inventory for Tank 241-T-101 as of May 1, 2021
RPP-RPT-58239	00	Fiscal Year 2014 Visual Inspection Report for Single-Shell Tanks

DOCUMENT RELEASE AND CHANGE FORM

Doc No: RPP-RPT-65234 **Rev.** 00

13. **Related Documents** ☐N/A

Document Number	Rev.	Title
RPP-RPT-59273	00	Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06
RPP-RPT-60305	03	Single-Shell Tank Updated Drainable Interstitial Liquid Volumes - 2020
RPP-RPT-61929	00	Evaporation of Water from Single-Shell Tanks using Active Ventilation
RPP-RPT-63813	00	VMDS Quantitative Risk Analysis 241-T Tank Farm
RPP-RPT-64081	00	241-B-109 Active Ventilation Practicability Evaluation
RPP-RPT-65071	00	2024 Leak Assessment Report for Tank 241-T-101
RPP-TE-58793	00	Single Shell Tanks (SST) Breather Filter Isolation Evaluation
W-71387 SH 001	19	75 FT DIAM TANKS BUILDING 241 CONCRETE DETAILS OF TANK
W-72743 SH 001	19	75 FT. 0 IN. DIA. STORAGE TANKS T-U-B AND C ARRANGEMENT
WHC-SD-WM-TI-302	00	HANFORD WASTE TANK SLUICING HISTORY
WHC-SD-WM-TI-665	00E	Soil Load Above Hanford Waste Storage Tanks

14. **Distribution**

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Anderson, Joshua M	OPS SUPPORT & STE
Andres, Brian D	CSE & RELIABILITY ENGINEERING
Baide, Dan	ENGINEERING
Bang, Ricky	TANK WASTE OPERATIONS (TWO)
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INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: 241-T-101 Active Ventilation Practicability Evaluation

Information Category:
☐ Abstract ☐ Journal Article ☐ Summary
☐ Internet ☐ Visual Aid ☐ Software
☐ Full Paper ☑ Report ☐ Other

Publish to OSTI? ☐ Yes ☑ No

Trademark/Copyright "Right to Use" Information or Permission Documentation	Yes ☐	NA ☑

Document Number: RPP-RPT-65234 Revision 0 Date: December 2024

Author: Brown, Tony N

Part II: External/Public Presentation Information

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Sponsoring Organization(s): WRPS

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.)*

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If product contains pictures, safety review completed?	☑	☐	Roberts, Sheryl K IDMS Data File att. 12/30/2024

Part IV: WRPS Internal Review

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Responsible Manager	WRPS	12/30/2024	Moberg, Timothy P R Bhatia for TP Moberg
Other:			IDMS Data File att.

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DOE – ORP Public Affairs/Communications	☑	☐	IDMS Data File att.	Dawson, Edward M
Other: DOE SME	☑	☐	IDMS Data File att.	Nelson, Erik N
Other:	☐	☐		

Comments Required for WRPS-Indicate Purpose of Document:

The purpose of this report is to demonstrate the practicability of installing and operating an active ventilation system as an interim leak response at Tank 241-T-101 (Tank T-101).

APPROVED
By Janis Aardal at 2:41 pm, Jan 13, 2025

Approved for Public Release; Further Dissemination Unlimited

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RPP-RPT-65234
Revision 0

241-T-101 Active Ventilation Practicability Evaluation

A. N. Brown
Washington River Protection Solutions, LLC

Date Published
December 2024

Prepared for the U.S. Department of Energy
Hanford Field Office

Contract No. DE-AC27-08RV14800

EXECUTIVE SUMMARY

This report supports U.S. Department of Energy (DOE), Hanford Field Office, compliance with the Addendum to the AGREED ORDER DOCKET No. 21304 (Agreed Order), Section V.C.1 which requires the completion of Air Emissions Evaluation for Tank 241-T-101. Quoting from Sections V.C.1.i through V.C.1.iii as modified by the Addendum:

- By January 1, 2025, "USDOE must perform an evaluation as to the practicability of installing and operating an active ventilation system for tank 241-T-101 and, if applicable, develop an active ventilation work plan as an interim leak response action."

Additionally, as stated in the Agreed Order:

- "The evaluation must include a consideration of whether installation and operation of an active ventilation system to evaporate liquid waste from Tank T-101 would create a new emission point under the Hanford Site Air Operation Permit or otherwise trigger additional air permitting requirements."

- "Installation will not be required if, based on the approved evaluation, USDOE determines that installation (i) would create a new emission point or (ii) compromise nuclear safety requirements or (iii) permitting or other requirements or issues (e.g. design limitation, scaling limitations) would pose an unreasonable impediment to proceeding to installation."

This practicability evaluation considers whether the installation and operation of an active ventilation system to mitigate potential leakage from Tank 241-T-101 would create a new emission point under the Hanford Site Air Operation Permit and trigger additional air permitting requirements. The criteria considered for practicability are functionality, permitting, the anticipated effects on the tank waste and leak rate, nuclear safety impacts, worker hazards, ALARA principles, schedule, and cost/resources.

Ventilation is expected to be effective at evaporating water in Tank 241-T-101. Considering current tank waste conditions, this report shows active ventilation could, from the waste in Tank 241-T-101, remove surface liquid (supernatant ~7000 gallons) and interstitial water from approximately the first 12 in. of the solids sublayer (saltcake ~7900 gallons). The efficiency of evaporation will significantly decrease once the pool is diminished and liquids evaporate from the saltcake. For tank 241-T-101, this corresponds to a total volume of approximately 14,900 gallons that can be evaporated.

This practicability evaluation presents the installation and operation of an active ventilation system on Tank 241-T-101 which would create a new emission point under the Hanford Site Air Operating Permit and will trigger additional air permitting requirements. Based on current data, presented in APPENDIX 2, analysis shows an exhauster actively ventilating Tank 241-T-101 at greater than 38 acfm would result in toxic air pollutant emissions above *de minimis* thresholds (specifically for the concentration of 1,3-Butadiene). The 38 acfm is a minimal flow rate that would not be effective at evaporating and diminishing water from the waste in this tank. A

significantly larger flow rate would be required to adequately remove water and would create a new emission point under the Hanford Site Air Operating Permit.

The evaluation in this report demonstrates there are no technical factors that would preclude installation of an active ventilation system for Tank 241-T-101 as a leak response measure. It also demonstrates that deploying active ventilation on this tank will constitute a new emission point for criteria and toxic air pollutants under the site's Air Operating Permit, because it will operate at a rate that results in discharge of exhaust gases to the atmosphere that are greater than the defined *de minimis* threshold. The overall determination of practicability, therefore, becomes a cost-benefit analysis that considers risk reduction, cost, schedule for implementation and permitting requirements, and the overall impact to the tank waste treatment mission.

Based on the data presented, the deployment of single-pass ventilation as an interim leak response action for Tank 241-T-101 would evaporate water and reduce the volume of material available to leak from Tank T- 101, which reduces the risk to the public and the environment. In addition, the infrastructure necessary to implement the action (e.g., utilities) is largely in place or can be readily installed, leading to the conclusion that the response is potentially possible in terms of schedule and cost.

Permitting for a new emission point (chemical – 8th paragraph) is a standard process that requires 9-12 months from initiation with the Washington Department of Ecology. A radioactive air permit from the Department of Health can be processed and acquired during the same time period. There are no anticipated complexities for Tank T-101. Required dispersion modeling is also not anticipated but could be performed during the same timeframe.

On this basis, the evaluation shows it is feasible to install an active single pass ventilation system on Tank 241-T-101 as an interim leak response action. However, this evaluation concludes that installation of a single-pass ventilation system will create a new emission point under the Hanford Site Air Operating Permit that will require a toxic air permit and additional programmatic complexity and schedule. Consistent with Section V.C.1.iii of the Agreed Order, installation will not be required and therefore not pursued.

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TABLES

FIGURES

APPENDICES

LIST OF TERMS

Abbreviations, Initialisms, and Acronyms:

ALARA	As Low As Reasonably Achievable
AOP	Air Operating Permit
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
B-109	Tank 241-B-109
BBI	Best Basis Inventory
BBIM	Best Basis Inventory Maintenance Application
BBS	Below Ground Surface
CFD	Computational Fluid Dynamics
CWR2	REDOX classing waste, aluminum clad fuel (1961-1966)
DIL	Drainable Interstitial Liquid
DOE	U.S. Department of Energy
DST	Double-Shell Tank
Ecology	State of Washington, Department of Ecology
ETF	Effluent Treatment Facility
FY	Fiscal Year
HDW	Hanford Defined Waste
HEPA	High Efficiency Particulate Air
HMIS	Hanford Mission Integration Solutions
ILL	Interstitial Liquid Level
ISB	Interim Surface Barrier
LFL	Lower Flammability Limit
LOW	Liquid Observation Well
MW	Metal Waste
OSD	Operating Specification Document
PCB	Polychlorinated Biphenyls
RCRA	Resource Conservation and Recovery Act
REDOX	Reduction and Oxidation Plant
SST	Single-Shell Tank
SWIHD	Site Wide Industrial Health Database
T-101	Tank 241-T-101
T-111	Tank 241-T-111
TAP	Toxic Air Pollutant
TFLAN	Tank Farm Local Area Network

TMACS	Tank Monitoring and Control System
TWINS	Tank Waste Information Network System
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company
WRPS	Washington River Protection Solutions

UNITS

%	Percent
acfm	Actual Cubic Feet per Minute
cfm	Cubic Feet per Minute
°F	Degrees Fahrenheit
ft	Feet
g	Gram
in.w.g.	Inches of water gauge
kgal	Kilogallons – 1000 gallons
kip	One-Thousand Pounds (force)
kL	Kiloliters
lbf	Pounds (force)
ml	milliliters
% RH	Percent Relative Humidity
scfm	Standard Cubic Feet per Minute
V	Volts

1.0 PURPOSE AND SCOPE

The purpose of this report is to demonstrate the practicability of installing and operating an active ventilation system as an interim leak response at Tank 241-T-101 (Tank T-101).

A similar practicability report, RPP-RPT-64081, was previously generated for leaking Tank 241-B-109 (tank B-109). The two tanks share a common physical configuration: of risers, a 75-foot diameter and a 530,000-gallon volume. Although the contents are chemically different, they share a general material likeness consisting of layers of sludge, saltcake, and liquid supernatant.

The B-109 report evaluated the effectiveness and practicability of several ventilation systems that included various alternatives for preconditioning the entering airstream and managing the generated condensate. The determination of RPP-RPT-64081 was that a single-pass ventilation system is the simplest and most well understood, and therefore, the most practicable.

This practicability report for tank T-101 relies on the determination for tank B-109 and builds on the practicability of deploying an active single-pass ventilation system for tank 241-T-101.

This evaluation utilizes the previous work performed for the B-109 ventilation as documented in RPP-RPT-64081. Some sections of this document restate sections of the B-109 evaluation in part or in whole, depending on the applicability to T-101.

1.1 SCOPE

This report presents background for the design/construction information, current status, and practicability of installing and operating an active ventilation system for 241-T-101. It also describes the baseline configuration and current conditions of 241-T-101. Although it briefly touches on the same alternatives as proposed for 241-B-109, this report concludes that only the single-pass ventilation system is reasonably feasible for 241-T-101.

2.0 BACKGROUND

2.1 DESCRIPTION AND CHRONOLOGY OF 241-T-101

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. Radioactive and chemical process waste contained in the tanks exists in one of three following tank waste forms: supernatant, saltcake, or sludge (saltcake and sludge usually have some interstitial liquid as specified in RPP-57039 within the pores of these solids). Waste has presently been retrieved from 20 of these SSTs.

The 241-T Tank Farm (TF), was constructed in the 200 West Area between 1943 and 1944. Tank farm 241-T contains twelve 100-series SSTs, each of which are 75 ft in diameter with a capacity to hold 530,000 gallons of waste (references W-72743 1978, Bld.241 and W-71387, 1978). Three tanks are connected by a 3-in. diameter cascade overflow line, beginning with Tank T-101 which flows into Tank 241-T-102 (T-102) and ends with Tank 241-T-103 (T-103). The headspace volumes of these three tanks are connected by these overflow lines.

The 241-T tanks were designed with primary, mild steel-lined concrete shells, dished bases with 4-ft radius knuckles and concrete domes with various risers. The tanks are set on a reinforced concrete foundation and covered with approximately 6.5 ft of backfill material over the dome (see WHC-SD-WM-TI-665, *Soil Load Above Hanford Waste Storage Tanks*). The foundation of the T Farm excavation is approximately 38 ft below ground surface. This allows space for footings and other construction requirements. Figure 4-1 shows the waste tank isolation drawing for Tank T-101 which details the inlet and outlet cascade lines, spare inlet nozzles, risers, and other tank features. Nozzle N1 is the cascade outlet line which flows to Tank T-102 (see drawing H-2-73059, Sheet 1, *Piping Waste Tank Isolation 241-T-101*).

Dissolution of metals produced during the recovery of plutonium from nuclear fuel created Metal Waste (MW) Tank T-101 entered service in the last quarter of 1944 to receive this metal waste from T Plant in December of that same year (WHC-MR-0132, *A History of the 200 Area Tank Farms*). The metal waste in Tank T-101 began cascading to Tank T-102 in September 1945, and in February 1946, the waste at the end of the overflow cascade filled Tank T-103. Metal waste was stored in Tank T-101 until mid-1953 when the waste was sluiced and removed. After the waste was removed from T-101, the tank was filled with ferrocyanide sludge produced by scavenging of waste from uranium recovery processes. By late 1953, approximately 254,000 gallons of waste was transferred from T-101 to other tanks, and another 256,000 gallons of tank waste was sent from the three tanks to cribs for disposal. Any remaining tank waste was then flushed with water and transferred to other tanks.

In early 1955, again metal waste from T Plant began filling Tank T-101, and by mid-1955 the waste was cascading into Tank T-102. Sluicing operations to remove metal waste began in early 1956 and dropped the liquid level to the heel of the tank. Between 1957 and early 1963, small quantities of metal-coating waste from T Plant were moved into the tank for storage. By mid-1963, Tank T-101 was filled with coating waste. In early 1969, it was transferred to Tank T-103.

T-101 did not receive additional waste until 1972, when the tank received waste from the 241-SX and 241-BX Tank Farms along with waste from other T Farm tanks. The tank was removed from service in 1979 and declared inactive in 1980 (RPP-RPT-58186, *Derivation of Best*-Basis *Inventory for Tank 241-T-101 as of May 1, 2021*). Tank T-101 was then declared an assumed leaker in 1992 (RL-WHC-TANKFARM-1992-0073, *Apparent Decrease in Liquid Level in Single Shell Underground Storage Tank 241-T-101*) and subsequently Tank T-101 was interim stabilized in 1993 (HNF-SD-RE-TI-178, *Single Shell Tank Leak Stabilization Record*).

Within the last several revisions of HNF-EP-0182 (*Waste Tank Summary Report for Month Ending October 31, 2024*, Rev 442) Tank 241-T-101 has been included in the Single Shell Tanks with Confirmed Water Intrusion. The date of the video inspection driving that listing was 3/10/2014.

A leak assessment was completed in 2019 that resulted in changing the T-101 status from "assumed leaker" to "sound." No unexplained liquid level decrease in the tank was observed from 1945 to 2019 (RPP-ASMT-62935). However, a 2024 in-tank inspection showed a decrease in the liquid pool between 2014 and 2024 and a decreasing trend in surface level measurements was observed. An assessment in 2024 concluded that the tank was leaking (RPP-RPT-65071), and the status of tank 241-T-101 was changed to "assumed leaker" at the Executive Safety Review Board on August 15, 2024 (RPP-RPT-65071, Rev. 0, *2024 Leak Assessment Report for Tank 241-T-101*). This is documented in HNF-EP-0182, Rev. 441, *Waste Tank Summary Report for Month Ending September 30, 2024.*

Experimental and modeling studies that were used in the analysis of evaporation from Tank B-109 are referenced in Appendix 1, which estimate evaporation of water from as deep as 12 inches below the porous saltcake surface. Previous saltcake analysis showed the average saltcake drainable porosity was 0.24, meaning 24% of the saturated saltcake volume is drainable and could potentially be evaporated. A 12-in. depth of salt cake would be a volume of 2,750 gal/in. times 12 inches equals 33,000 gallons of saltcake with interstitial liquid. The amount of interstitial liquid that could potentially be evaporated is 33,000 times 0.24 equals 7,900 gallons. This amount plus 7,000 gallons of supernatant adds to a total of 14,900 gallons of liquid that could be removed by active ventilation.

As of September 30, 2024, the volume of materials in tank 241-T-101 were reported as follows: Total Waste is 93 kgal; Drainable Interstitial Liquid volume is 11 kgal; Supernatant is 7 kgal; Sludge is 37 kgal; and Saltcake is 49 kgal. The supernatant and a portion (approximately 12 inches) of the interstitial liquid level should be available for evaporation. The liquid pool currently covers 81% of the waste surface and the saltcake is assumed to be saturated (RPP-RPT-60305, Rev 3).

2.2 DEPLOYMENT OF ACTIVE VENTILATION ON SINGLE-SHELL TANKS

Active ventilation to remove water from a leaking SST (RPP-PLAN-57554, Rev. 0, 2014) to dry the waste was previously implemented on Tank 241-T-111 in July 2015 until April 2019. As

reported in RPP-RPT-59273, *Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06*, water was evaporated with the intent of reducing the volume of tank liquid that could leak into the soil surrounding the tank. The results obtained by deploying active ventilation on Tank-241-T-111 prompted a study of the potential effects of using this technology to remove water from other SSTs. In 2019, RPP-RPT-61929, *Evaporation of Water from Single-Shell Tanks using Active Ventilation,* was issued to report the potential volume of water which could be removed from the SST System by this method.

RPP-RPT-59273, *Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06*, reported that approximately 7,150 gallons of water was evaporated from tank T-111. The evaporated liquid included 10% (approximately 700 gallons) from the pool and 90% (6450 gallons) from the surrounding sludge. The evaporation rate varied between approximately one to 11 gallons/24 hours/100 scfm. The ventilation flowrate varied but was typically around 450 scfm.

Tank T-101 has significantly more supernatant and pool surface area than did Tank T-111. Therefore, it is expected that initially the evaporation rate will be greater than that for Tank T-111. The rate will depend primarily on the ventilation flowrate. Once the pool has evaporated, interstitial liquid will be removed.

2.3 GENERAL CRITERIA FOR DETERMINING PRACTICABILITY

For purposes of this study, practicable is defined to mean those strategies that are both possible (i.e., technically feasible) and that when implemented, will minimize the risk posed by the Hanford Tank waste to the environment and human health.

Additionally, practicability includes consideration of funding and resource availability, as well as impacts to the River Protection Project tank waste treatment and risk reduction mission. Precise estimates of those costs are beyond the exploratory nature of this document.

This evaluation considers the relative practicability of Single-Pass active ventilation under the following criteria:

- Functionality and Feasibility (including design and scaling limitations)
- Condensate Management
- Permitting
- Impacts on tank waste, waste volume, and leak rate
- Nuclear Safety Impacts
- Worker Hazards
- As Low as Reasonably Achievable
- Schedule
- Cost/Resources

3.0 DESCRIPTION OF ACTIVE VENTILATION CONFIGURATIONS EVALUATED FOR PRACTICABILITY

This section describes the physical properties of ambient air and tank waste that will affect the evaporation rate for Tank 241-T-101. The active ventilation technologies, configurations, and ventilation systems that were previously evaluated for appropriateness and practicability for tank 241-B-109 in RPP-RPT-64081 are not re-evaluated here. Instead, this report solely considers the practicability of the Single-Pass Ventilation option for Tank 241-T-101. That option was previously found to be the most practicable in RPP-RPT-64081. Due to the similarity of the evaporation process, re-evaluation is not necessary. Those alternate configurations are briefly mentioned but not further evaluated for practicability in this section. The overall practicability results are summarized in Section 5.0.

3.1 PHYSICAL PROPERTIES IMPACTING THE PRACTICABILITY OF WATER EVAPORATION VIA ACTIVE VENTILATION OF 241-T-101

The removal of water by evaporation from the liquid surface, and from the interstitial subsurface liquid, can reduce the hydrostatic pressure which contributes to leakage from the tank, as well as remove liquid which could potentially leak from the tank.

Evaporation of pooled liquid water is a function involving: the liquid temperature, which drives the vapor pressure to evaporate; the temperature and humidity of the air at the surface interface (warmer air can hold more evaporated water vapor); the path and rate of air flow; and the liquid pool surface area that interfaces with the airflow. Therefore, the greatest evaporation occurs when the liquid temperature is warmest (greatest vapor pressure), the air is warm and of low humidity (dry), and it flows across a large liquid pool (see *The Dehumidification Handbook*, pp 70-71).

Evaporation of interstitial liquid from the porous solids is initially controlled by capillary action and is expected to continue at about the same rate as evaporation of the liquid pool. When the moisture content of the saltcake is low enough, and the depth of the saturated saltcake deep enough (about 12 inches), liquids no longer reach the surface by capillary forces, but slowly migrate by diffusion, and the evaporation rate becomes negligible (See Appendix 1, pages 4-6 and 4-7).

Given these parameters, a properly designed active ventilation system is capable of evaporating water from the waste. The relative effectiveness of evaporation (i.e., the speed of evaporation) will depend on the interfacing configuration of the tank liquid and the deployed ventilation system configuration.

Evaporation occurs at the interface between the air and the liquid. Greater pool surface areas (i.e., pools of supernatant liquid) result in higher evaporation rates. A large portion of the liquids subject to evaporation in 241-T-101 is contained in the interstitial pores and void spaces of the saltcake layer. Evaporation of the saltcake interstitial liquid will begin after the liquid pool is removed.

There are no mechanical or engineered components in this technology to either stir or force liquid to the tank waste surface. Instead, capillary action (i.e., “wicking”) is expected to lift some fraction of the tank’s interstitial liquid from below the waste surface, exposing it to the effects of active ventilation. This behavior is described in the analysis presented in Appendix 1 and in detailed observations of active ventilation performance at Tank 241-T-111, as documented in RPP-RPT-59273, *Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06*.

Observations from actively ventilating Tank 241-T-111 showed that, while evaporation of water from the supernatant pool occurred at a high rate, the majority of water volume was evaporated from the interstitial liquid contained in the sludge (see RPP-RPT-59273). This confirms that interstitial liquids are removed via capillary action and evaporation, even if solid particles form the waste surface.

An analysis of evaporation rates for tank B-109 was reported in Attachment 4 of RPP-RPT-64081. The evaluation in that document uses computational fluid dynamics (CFD) to model the complex air currents formed in an SST dome and predicts the velocity of air across the waste surface at different ventilation flow rates.

The flow rate in a single-pass ventilation system, as presented for utilization in Tank 241-B-109, was limited to the volume of air that can be exhausted without requiring additional permitting, due to hazardous constituents (a.k.a., *de minimis* emission limits).

The allowable flow rate to stay under the *de minimis* amounts (specifically for the concentration of 1,3-Butadiene) without requiring additional permitting for 241-T-101 is 38 acfm, Appendix 2. The hazardous chemical content of Tank 241-T-101 is greater and a flow rate of 38 acfm is too low for an acceptable evaporation rate. Therefore, an effective, active ventilation cannot be performed without first acquiring an emission permit for tank 241-T-101.

3.2 SINGLE-PASS VENTILATION

In a single-pass ventilation system (shown schematically in Figure 3.1), ambient air enters the tank via an inlet assembly. Evaporation from the waste liquid increases the humidity of this incoming air. A fan pulls the air from the tank through a high efficiency particulate air (HEPA) filter prior to release via a stack to the surrounding environment. The stack discharge is additionally monitored for radioactive emissions. Any incidental condensation within the exhaust ductwork is collected and returned by gravity to the tank.

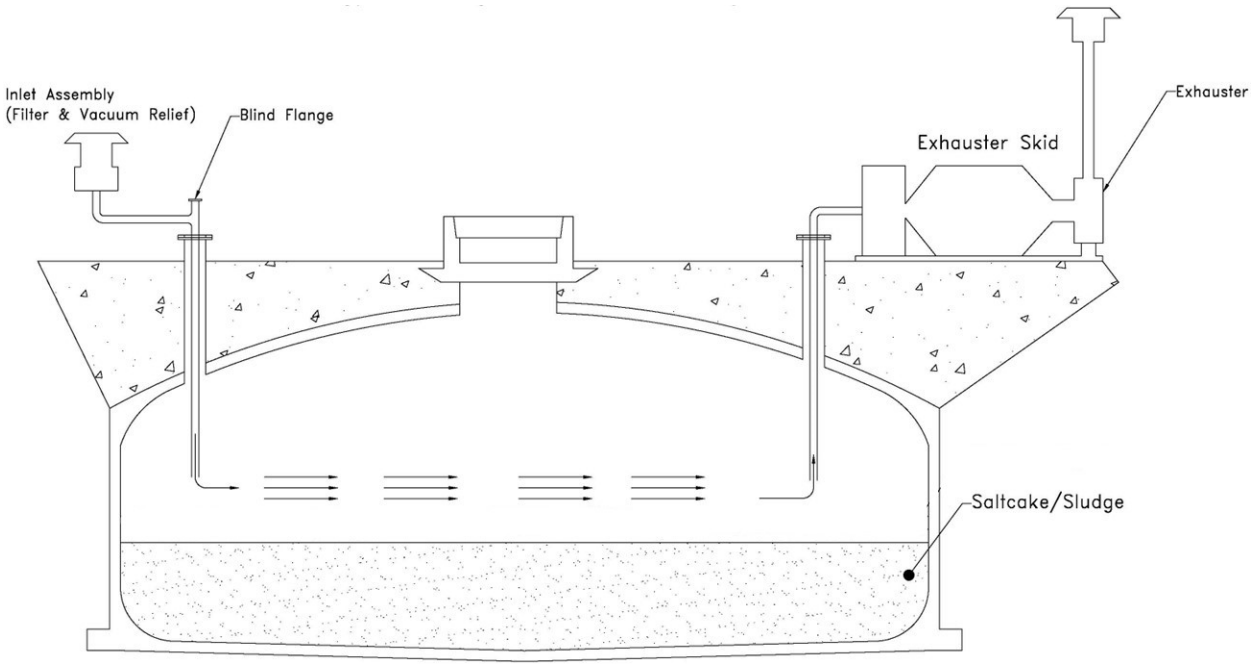

Figure 3-1. Single Pass Ventilation System

Using a single-pass ventilation system to remove water by evaporation is a simple process with existing methods to return a minimal amount of condensate back into the tank. This technology is a relatively passive water reduction technique that does not disturb the solid part of the waste.

Single-pass ventilation has been implemented across the Hanford tank farms. Although not used for the specific purpose of evaporating water, single-pass ventilation systems are used in all six of Hanford's double-shell tank farms and have been deployed to support SST retrieval and saltwell pumping operations.

The single-pass ventilation option was selected for implementation in Tank 241-B-109 and is the only option evaluated for tank 241-T-101 in this report. The single-pass option would require the shortest length of time to install and implement. The other options will be minimally mentioned below and referenced to the previous report.

Previously, Tank 241-T-111 used a similar single-pass ventilation system at 450 cfm to successfully remove water by evaporation from July 2015 to April 2019, as documented in RPP-RPT-61929, *Evaporation of Water from Single-Shell Tanks using Active Ventilation,* and RPP-RPT-59273, *Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06*.

3.3 PRECONDITIONING VENTILATION OPTIONS PREVIOUSLY PRESENTED IN RPP-RPT-64081 FOR TANK 241-B-109

RPP-RPT-64081 evaluated four options for preconditioning of the ventilation air. None of these preconditioning options were selected for further evaluation. These options will be minimally presented below with reasoning as to why they were not selected or be re-evaluated herein.

3.3.1 Single-Pass Ventilation with Inlet Air Preconditioning

Inlet air preconditioning was not selected. Preconditioning may increase evaporation, but it also adds substantial system complexity, start-up costs, and maintenance costs. Deployment and design of such an integrated system may well include other unforeseen costs and complexities.

3.3.2 Dehumidification using Desiccant Dryer Only

Desiccants attract moisture from the air by providing an absorbent volume for water vapor to move from the air into the desiccant. A cyclical system then reintroduces the dried air back into the tank to absorb more water vapor. The desiccant, however, requires a heater, and a separate and secondary flow of air to dry and regenerate the moistened desiccant. This separate and secondary continuous volume of air, used to dry the desiccant, is finally exhausted to the atmosphere with whatever it has absorbed from the desiccant. The desiccant will likely absorb more than just water vapor, and the system will exhaust those constituents to the atmosphere as well.

This is a complex system involving continuous rotation of the desiccant and two separate air flows; therefore, this option was not selected.

3.3.3 Preheat with Heating Coil Only

Placing a heating coil at a tank’s ventilation inlet increases the temperature and decreases the humidity of the air passing through the tank which increases the evaporation rate. However, adding a heating coil significantly adds undue complexity to the ventilation system. Therefore, this option was not selected.

3.3.4 Dehumidification and Reheating using Cooling and Heating Coils

Combined cooling of fresh air to the condensation point, collecting the condensate, and then reheating this inlet air reduces the overall humidity of the air entering the tank, thereby increasing evaporation to the air stream.

This option also adds substantial complexity to the single-pass ventilation system with the addition of a cooling system followed by a heating system. Similarly to the other systems presented in RPP-RPT-64081, there would be unjustified challenges, and this option was not selected.

3.3.5 Air Recirculation with Condensate Recovery

Air recirculation and condensate recovery from the air exhausted from the tank (evaporated liquid from the tank) is a closed loop ventilation system. No air is discharged into the atmosphere.

This is similar to the cooling and reheating of Section 3.3.4, except the collected condensate is the evaporated water from the tank and this condensate would need to be removed and disposed. Therefore, this option was not selected.

4.0 241-T-101 ACTIVE VENTILATION PRACTICABILITY EVALUATION

4.1 FUNCTIONALITY AND FEASIBILITY OF INSTALLATION AND OPERATION

The previously discussed ventilation technologies, configurations, and systems each require supporting infrastructure for installation and operation. This section and its subsections evaluate the practicability of both installation and operation for a single-pass ventilation system for leak response. System sizing, dome load constraints, riser availability, space for installation, utilities, tank interfaces, and condensate management pathways are discussed for the T-Tank Farm in this section.

4.1.1 System Sizing Evaluation

Portable exhausters have been deployed throughout the waste tank complex at Hanford. Similar to what was used for Tank T-111 (450 cfm), a portable exhauster capable of operating at 300 acfm or more is the preferred size for a ventilation system to achieve removal of evaporated liquid from Tank 241-T-101. This justification is also provided in RPP-RPT-59273, *Evaporation of Water from Single-Shell Tank 241-T-111 with 500 CFM Portable Exhauster POR06.*

Table 4-1. Estimate Equipment Size for Active Ventilation Systems

Configuration	Portable Exhauster Size
Single-Pass Ventilation System	Using POR06 (500 acfm capacity) as a basis, the portable exhauster is 20’ 2-1/8” L × 5’ 8” W × 17’ 0-3/4” H (H-14-100867, Sh. 7 & 8). Total assembled weight is approximately 8900 lbs (H-14-100867, Sh. 2, Note 5). Large concrete blocks were used to elevate the exhauster when it was deployed at 241-T-111. The estimated weight of these blocks is an additional 19,000 lbs (H-14-110122, Sh. 1) for a total weight of 27,000 lbs. Note that additional clearances are required for filter changeout and maintenance; including a potential need to drain overfull seal pot.

In examining the general layout of T-Farm, the size of ventilation system components shown in Table 4-1 can be accommodated without interference with other at-grade equipment. Considering the load-bearing capacity of Hanford site soils, the weight of this component can be accommodated without special controls at T-Farm tank 241-T-101.

See drawings H-2-829116, H-2-829117, H-14-100867, and H-14-110122 as referenced in the POR06 information.

4.1.2 Dome Loading Constraints Evaluation

The Tank Farms Documented Safety Analysis (RPP-11802, Rev. 04C and RPP-13033) requires Engineering to provide controls and monitoring to maintain the structural integrity of the domes of both SSTs and DSTs. Dome loading requirements provide a defense-in-depth against dome

collapse and are contained in OSD-T-151-00013, Rev 11, *Operating Specifications for Single-Shell Waste Storage Tanks*, and TFC-ENG-FACSUP-C-10, Rev D-4, *Control of Dome Loading and SSC Load Control.*

The tank dome for 241-T-101 has an allowable concentrated load of 342,000 lbf, an existing permanent load of 9,849 lbf, and currently does not have extra equipment that would increase the total dome load. This means that the remaining margin to dome load is 332,151 lbf.

Portable POR06, the exhauster used at 241-T-111, weighs approximately 9,500 lbs. This is less than 3% of the current remaining margin for T-101. The construction location of the exhauster is also likely to be outside of the dome's exclusion zone due to plans for construction of the Interim Surface Barrier (ISB, 12823-DCP-SHT 2). Because of these reasons, dome load limits are unlikely to be a bounding factor.

4.1.3 Riser Availability and Selection Evaluation

Tank 241-T-101 has four 4-inch risers, six 12-inch risers, one 42-inch riser, and one 18.6 sq ft hatchway cover. Currently, RISER-003 and RISER-006 are listed as "empty" or "spare". RISER-003 and RISER-006 are in different pits on opposite sides of the tank and could provide the maximum pathway for air flow across the surface of the waste (Figure 4-1, drawing H-2-73059).

RISER-003 is in the sluice pit (northeast side of tank). RISER-006 is in the pump pit on the southwest side of tank. These two pits have been foamed over and would need to be accessed to put either riser into service. It should be noted that all pits are tentatively scheduled to be covered with approximately two feet of soil and paved over during the installation of the new interim surface barrier (ISB) scheduled for 2026. Installation of a single-pass ventilation system prior to installation of the ISB would not require sub-surface location of components, excavation, and resealing of the surface.

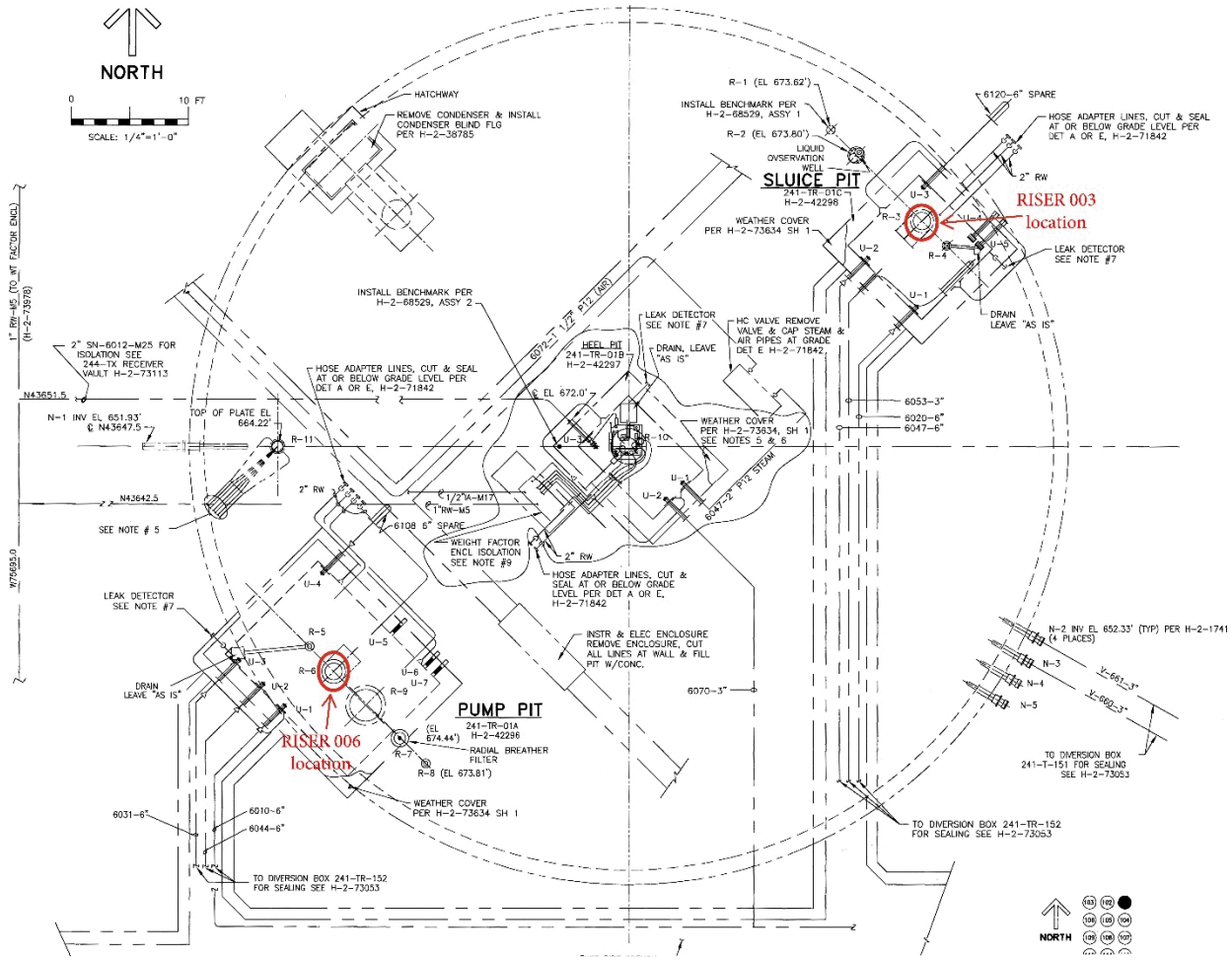

Figure 4-1. Tank T-101 Plan View Showing Potential Risers for Ventilation System Use.

4.1.4 Evaluation of System Location and Space Constraints within T-Farm

The 241-T Tank Farm has open space that would be viable for reuse of an existing exhauster such as POR06, or the construction of a new exhauster just to the east of T-101 (see Figure 4-2). However, there are considerations when selecting a precise location. The first consideration is that this location has an uneven grade and would need to be flattened to allow for construction. However, the sloped elevation difference could be used to provide a natural gravity drain back into Tank T-101 for any condensate that is collected. The second consideration is the edge of the proposed ISB. This edge is proposed to be located approximately 120 feet from the East fence-line, which will provide sufficient room for the footprint of an exhauster off the ISB. Drawings depicting the northeast corner of the farm were reviewed (H-2-44511, *Area Map 200 West "T" Plant Facilities* and EDT-884599, 2024*, 241-T Tank Farm Interim Surface Barrier Design Drawing Initial Release*), and only one underground pipe near the fence-line was found that will not significantly reduce the available area.

See the red-outlined region in Figure 4-2 below, for the available area to place an exhauster system by either re-using (POR06) or implementing a new construction.

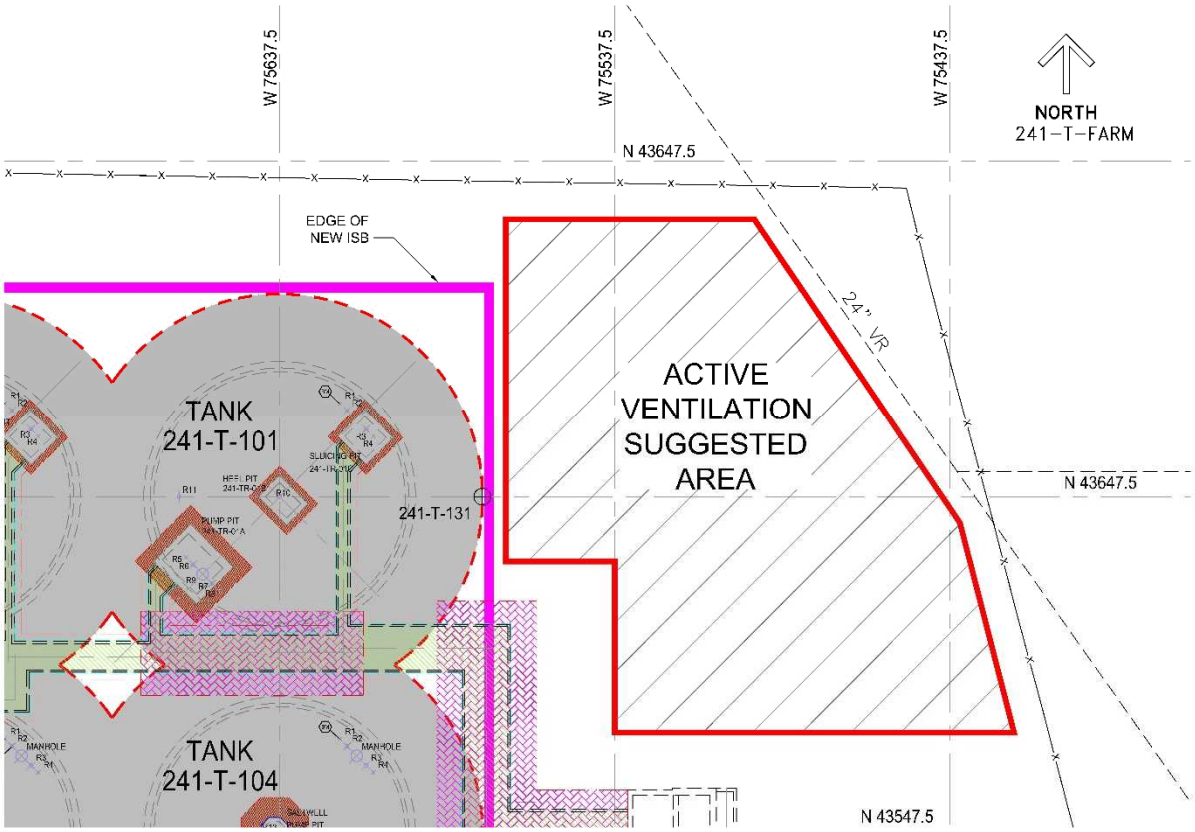

Figure 4-2. Suggested Area of Exhauster System Placement

4.1.5 Electrical Utility Availability Evaluation

Active ventilation systems require electrical power for operation and cabling for instrumentation and controls. Other utilities such as water or compressed gases are not required. Portable exhausters can be either hard-wired or powered from portable generators.

Adequate electrical power is available. Currently, hard-wired power is available from three transformers, each rated at 10 kVA, providing a combined total of 30 kVA. After accounting for connected loads, there is still 14 kVA available from these three transformers. Power from these transformers could be provided but would require a 500 to 600-ft cable run to the exhauster.

Additionally, there are transformers located on the northeast side of 241-T with 5 kVA. These transformers are also utilized by a contractor other than the Tank Operations Contractor and could create maintenance coordination challenges.

Should a new exhauster's power demand exceed 14 kVA, the existing 13.8 kV overhead lines located 80 ft north of 241-T-101 could support a larger transformer to meet the demand. This source would allow electrical connections for the electrical purveyor, Hanford Mission Integration Solutions.

4.1.6 Condensate Generation and Management Evaluation

Active ventilation systems form condensation. The generation of condensate is a naturally occurring phenomenon (i.e., dew and frost weather events are common), and it is unlikely that any active ventilation configuration can be designed to eliminate the occurrence of condensation (particularly during transient events like startup or weather changes).

4.1.6.1 Single-Pass Ventilation System Condensate Generation and Management

In a single-pass ventilation system configuration, condensate may accumulate in the ductwork as warm, humid air from the tank contacts the relatively cooler walls of the duct. The quantity of condensation that accumulates can be reduced by insulating and heat-tracing the ductwork.

For condensate formed in the ducting of a single-pass ventilation system, the most efficient technique is to return the condensate back into the tank using sloped duct and condensate piping (typically connected to the low point drain of a moisture separator). To limit the quantity of condensation generated, the duct should be insulated and heat traced.

Recapturing condensate by sloping the duct back to the source tank is passive and far simpler than collecting and separately managing condensate. This approach eliminates any need for collecting or transporting condensate but may reduce the net removal rate of liquid from the tank as a fraction of the evaporated liquid is returned to the tank. Considering the cost and complexity of capturing, collecting, transporting, and discharging condensate to a qualified receiver, systems that require separate condensate collection and disposition are not considered practicable.

4.2 PERMITTING EVALUATION

4.2.1 Toxic Air Permitting Evaluation

The decision-making process assumes that the installation and operation of an exhauster is not practicable if an emissions permit is necessary.

A new source review analysis per Washington Administrative Code (WAC) 173-400-110 was prepared for Tank 241-T-101 using estimated emissions based on existing headspace sampling data. The result of this analysis is the listing of expected emission constituents at 38 acfm, in Table 4-2.

Using the available Tank Waste Information Network System (TWINS) and Site Wide Industrial Hygiene Database (SWIHD) data over a range of exhauster flow rates, estimated criteria and toxic air pollutant (TAP) emissions were compared against regulatory thresholds in WAC 173-400-110 and 173-460-150 to determine whether a criteria or toxic air permit from Ecology would be required to operate an installed exhauster.

The calculations for 241-T-101 indicate discharge rates from active ventilation above 38 acfm (the estimated emissions *de minimis* limits in WAC 173-400-110(5) and WAC 173-460-150) would be exceeded. Therefore, installation of a ventilation system on Tank T-101 is not practicable. The calculation for 241-B-109 was significantly greater at 328 acfm and the proposal was for a maximum flowrate of 300 cfm. As a flowrate of 38 acfm is much lower and significantly less than required for effective evaporation, a new emissions point would need to be created under the Hanford Site Air Operating Permit (AOP) for Tank 241-T-101.

Table 4- summarizes and abbreviates the lesser amounts of estimated emissions calculations. The concentration of 1,3 Butadiene results in the limiting flowrate. The full report is included as Appendix 2.

Table 4-1. 241-T-101 Emission Evaluation at Exhauster Flow Rate of 38 ACFM

Compound/Chemical Name	CAS#	SWIHD and TWINS Highest Value (mg/m^3)	Tank Emissions (g/s)	Total Unit of Measure Based on Averaging Period (lbs/period)	Averaging Period for Specified TAP from WAC 173-460-150	% of De Minimis Threshold in WAC 173-460-150
1, 3-Butadiene	106-99-0	0.2146	3.89E-06	2.70E-01	year	100.00
N-Nitrosodiethylamine	55-18-5	0.0002	3.26E-09	2.26E-04	year	46.22
N-Nitrosodimethyamine	62-75-9	0.0002	3.26E-09	2.26E-04	year	20.59
Acrylonitrile	107-13-1	0.0043	7.87E-08	5.46E-03	year	19.50
N-Nitroso-N-methylethylamine	10595-95-6	0.0002	3.26E-09	2.26E-04	year	17.42
Mercury, elemental	7439-97-6	0.0030	5.44E-08	1.03E-05	24-hr	9.40
Acetaldehyde	75-07-0	0.2000	3.63E-06	2.52E-01	year	8.39
N-Nitrosodi-N-butylamine	924-16-3	0.0002	3.08E-09	2.14E-04	year	8.23
Acetonitrile	75-05-8	5.0523	9.16E-05	1.74E-02	24-hr	7.92

Chemicals with lesser *de minimis* amounts removed. Full resultant table in APPENDIX 2.

4.2.2 Radioactive Air Emissions Permitting

WAC 246-247 requires an AOP for emission of "radionuclides to the air." There are no *de minimis* amounts for radionuclides. Therefore, single-pass active ventilation equipment will constitute a new radiation emission point that must be incorporated into a new or existing AOP.

However, evaluation of the potential radionuclide emissions and the AOP they would be managed under are not included in this practicability evaluation. This permit for radioactive air emissions will constitute a new emission point (*prima facie)*. Note that permitting for radioactive air emissions is a routine activity at Hanford, with well-known and previously deployed emissions control technologies. Therefore, the need for a new license for radioactive air emissions is not a requirement that renders the anticipated response action impracticable.

4.3 EVALUATION OF ACTIVE VENTILATION IMPACTS ON TANK WASTE, WASTE VOLUME, AND LEAK RATE

This section discusses the effectiveness of active ventilation to evaporate water from the waste and the potential effect on the waste in Tank 241-T-101 and its cross-connected tanks.

4.3.1 Water Evaporation Rate Evaluation

The effectiveness of different configurations and preconditioning options was previously evaluated in RPP-RPT-64081, Rev 0, *241-B-109 Active Ventilation Practicability Evaluation*. A CFD analysis and ASHRAE evaporation calculation (2021 ASHRAE Handbook) were performed to estimate the relative evaporation rate of each ventilation configuration. It is expected that the effectiveness of an active ventilation system on 241-T-101 will perform similarly, if not better, due to its larger pool surface. A separate CFD analysis using the specific liquid and waste geometry in 241-T-101was not performed.

Additionally, it should be noted that the evaporation rate previously calculated for other tanks assumes a pool of free liquid at the surface of the waste with a surface area adjusted by a factor based on the waste porosity and the wetted surface. The actual evaporation rate will depend upon the liquid and waste profile in 241-T-101, and due to the configuration and content similarities with tanks B-109 and T-111, the relative effectiveness at 241-T-101 should prove comparable.

4.3.2 Effect of Water Evaporation on Leak Rate and Waste Volume Reduction

Removal of the upper volumes of liquid by evaporation at Tank 241-T-101 would reduce the hydrostatic force acting on the leak[1]. However, the evaporation process is not expected to reach or affect interstitial liquid at depths of greater than approximately 12 inches into the solid layers.

4.3.3 Impact of Evaporation on Waste Chemistry of 241-T-101

The saltcake layer of 241-T101 will likely become drier due to evaporation from its surface. Crystallization of these salts will occur, but particle binding and/or cementation is not expected.

[1] Based on the Darcy Equation for fluid flow, the leak rate from 241-T-101 would be cut in half if the hydrostatic pressure were reduced by 75%. If supernatant and the top 12-13 inches of interstitial liquid are removed from 241-T-101, there will be a substantial reduction in hydrostatic pressure.

The 241-T-101 sludge may harden due to evaporative drying, but the sludge is not expected to dry because it is below the surface of the saltcake. It is unlikely that the capillary action and evaporative drying would penetrate much farther below the uppermost solid surface of the waste.

4.3.4 Impact of Active Ventilation of 241-T-101 on Cross-Tied Tanks

Tank 241-T-101's headspace is directly connected to the headspace of Tank 241-T-102 via a 3-inch diameter SCH 80 pipe that is 30 ft long. 241-T-102 is then connected to Tank 241-T-103 in the same way, forming a three-tank cascade.

Based on experience at 241-T-111, a small amount of infiltration could be drawn from the cascaded Tanks T-102 (i.e., 7%) and T-103 during operation of an active ventilation system at 241-T-101.

Any ventilation configuration that requires a significant pressure drop across the headspace of Tank T-101 may result in additional flow through these cross-connections since 241-T-101 would be maintained at a greater vacuum in that scenario. Although the flowrate drawn from 241-T-102 is unlikely to be substantial, it remains a possibility. The added ventilation being drawn from connected tanks could potentially result in evaporation of liquids from 241-T-102 and 241-T-103 and affect the emission point permit as a separate source of pollutants. This connectivity is included in the attached Criteria and Toxics analysis in Appendix 2.

According to RPP-RPT-61929, Section 8.0, operation of the POR06 exhauster on Tank 241-T-111 halted in April 2019 over concerns that the active ventilation system was evaporating water from Tank 241-T-112 via the cascade line.

An approach that could eliminate flow of air from the cross-connected tank(s) is to temporarily close the inlet air filter for the cross-connected tank(s)[2]. This would reduce the infiltration flow as a vapor source from other tanks through the cascade line(s) connected to Tank 241-T-101.

4.4 NUCLEAR SAFETY IMPACTS EVALUATION

This section discusses limitations that must be imposed on an active ventilation system design to avoid compromising nuclear safety requirements.

Per RPP-13033, *Tank Farms Documented Safety Analysis,* to prevent steady-state flammable gas hazards in T-101, the SST Steady State Flammable Gas Control SAC requires flammable gas monitoring to directly verify that the flammable gas concentration in the tank headspace is ≤ 25% of the LFL. This confirms that sufficient ventilation is available to control the steady-state generation of flammable gas in the SST. Extensive flammable gas monitoring data on SSTs

[2] According to RPP-TE-58793, *Single Shell Tanks (SST) Breather Filter Isolation Evaluation,* Section 15, "Breather filters can be closed for a period of 30 days at a time. The valves would be reopened after the 30-day period (for a minimum of 24 hours) before reclosing the valves for another 30-day period. Documentation of breather filter closure and reopening is required."

demonstrate that passive ventilation (and/or diffusion), sufficient to prevent steady-state flammable gas hazards, is inherent in the normal operation and configuration of the SSTs.

Passive ventilation is currently present in T-101. If active ventilation is introduced into T-101 and it becomes not operable for any reason, then T-101 will need to return to passive ventilation to ensure that sufficient ventilation is available to control the steady-state generation of flammable gas.

Installation of an active ventilation system for T-101 may introduce additional hazardous conditions analyzed in RPP-15188, *Tank Farms Hazard Evaluation Database Report.* Existing hazard assessment and procedures applicable to installing and operating an active ventilation system can be expected to establish suitable controls for these types of hazards.

4.4.1 Operating Specification Requirements

OSD-T-151-00013, *Operating Specifications for Single-Shell Waste Storage Tanks*, limits the allowable vacuum for normal operations of T-Farm series 100 tanks to 1.5 in.w.g. (inches water gauge) plus the waste height measured in inches, or 3.0 in.w.g., whichever is lower.

Therefore, an active ventilation system deployed at Tank 241-T-101 will likely require the installation of a calibrated pressure transmitter and interlock to shut down the system's fan if the vacuum pressure reaches or exceeds the 3.0 in.w.g. limit.

Portable exhausters deployed on other tanks use this same method to ensure that the operating limits are not exceeded. Exhauster interlocks are also backed up by a vacuum relief controller assembly installed at the inlet of the tank that opens when the pressure in the tank drops below a specified value (typically, 0.25 in.w.g. or 0.50 in.w.g.; refer to H-14-106608 for more details).

4.5 WORKER HAZARDS EVALUATION

In general, active ventilation is one of the primary engineered controls for mitigating risks associated with tank vapors. To determine the required stack height, dispersion modeling may need to be performed. The modeling will likely consider the headspace concentrations, local wind directions, worker locations, stack heights, and other factors.

Since 241-T-101 is currently passively ventilated, cessation of the active ventilation system as in the case of power failure will not result in any anticipated operational or safety concerns, and 241-T-101 will return to a passive ventilation configuration when active ventilation is not operating.

Installation of an active Single-Pass ventilation system may change the exposure of workers in the vicinity to more head-space gases. A re-evaluation of the quantitative risk analysis (RPP-RPT-63813, *Vapor Monitoring & Detection System Quantitative Risk Analysis 241-T Tank Farm*, Rev 0, July 2022) and gas dispersion modeling for the new active ventilation configuration may both be needed.

Installation of an active ventilation system in T-Farm may introduce common industrial safety hazards such as slips, trips, and falls, potential exposure to noise, or potential exposure to electrical hazards. However, existing hazard assessment and industrial safety procedures applicable to installing and operating an active ventilation system can be expected to establish appropriate controls for these types of hazards.

Worker hazards, therefore, do not present an obstacle to installation and operation of an active ventilation system.

4.6 AS LOW AS REASONABLY ACHIEVABLE EVALUATION

Radiation exposures to workers and the public must be kept as low as reasonably achievable (ALARA) for safety and environmental protection. Active ventilation systems at Hanford have been deployed in the past, and they include many design and operating principles to keep exposure ALARA as listed below:

- Portable exhausters include dual stage HEPA filtration to remove potentially radioactive particulates from the exhausted airstream. HEPA filters are 99.97% effective for a particle size of 0.3 micron.
- Portable exhausters are designed to include differential pressure monitoring to ensure HEPA filters are functioning within their parameters and are changed before a potential rupture.
- Portable exhausters are designed with a monitored seal pot to ensure that air cannot bypass the HEPA filters.
- Portable exhausters are designed to include a heater upfront to ensure that liquid moisture does not collect on and potentially damage the HEPA filters.
- Portable exhausters include a continuous air monitor to ensure that emissions do not exceed environmental or safety limits. The exhauster is shut down if the emissions approach the maximum allowable limit.
- Portable exhausters are designed to operate automatically and remotely so that workers do not have to monitor them continuously, limiting radioactive source exposure.

Additionally, non-disturbing waste activities, such as the installation and operation of an active ventilation system on 241-T-101, are generally lower risk.

Previous Operating experience at 241-T-111 did not demonstrate any significant accumulations of radioactive particulates in the ductwork, moisture separators, or the portable exhauster filters.

A single-pass active ventilation configuration, as identified in this report, would meet ALARA principles.

4.7 SCHEDULE EVALUATION

Ventilation systems (such as the reuse of portable exhauster POR06) which can be deployed faster are better suited as an interim leak response.

Deployment of a new active ventilation system would potentially involve several activities:

1. Permitting for a new emission point (chemical – *de minimis*) is a standard process that requires 9-12 months from initiation with the Washington Department of Ecology. A radioactive air permit from the Department of Health can be processed and acquired during the same time period. There are no anticipated complexities for Tank T-101. Required dispersion modeling is also not anticipated but could be performed during the same timeframe.

2. Design. This includes the development of calculations, drawings, and specifications to establish and document the appropriate placement, power source(s), duct routing, condensate management, and equipment sizing of the active ventilation system.

3. Fabrication and/or refurbishment. This includes an assessment of the existing equipment available (i.e., portable exhausters) and their need for repair or maintenance before they can be reliably deployed in the field. It also includes the effort required to fabricate new ductwork, supports, etc.

4. Construction. This includes the effort required to place the equipment in the field and modify any items in the field to enable placement of the equipment for successful operation (e.g., temporary isolation of the cascade lines between the SSTs as discussed in Section 4.3.4).

5. Commissioning. For the portable exhausters, in-situ testing must be conducted to ensure that the HEPA filter housing is functional (and was not warped or damaged in transport) and to ensure that filtration efficiency continues to meet minimum standards. There would also be a period of time required to train operators and ensure that the equipment (including any interlocks or other controls) is functioning correctly.

Prior project experience shows the time required for tank-specific design, procurement of long-lead equipment, site preparation and installation, and start-up of an active ventilation system will likely require significant time. Use of an existing portable exhauster, such as POR06, may require less time.

The duration of operation for such a ventilation system would be dependent on the available liquid volume, the exhaust air flow rate, and the rate of evaporation or condensate removal achieved. Successfully reducing the volume would likely require months of operation, at a minimum.

If DOE is required to or elects to proceed with installation and operation of an active ventilation system on Tank T-101, the schedule durations will be refined in the Active Ventilation Work Plan that will be required under the Addendum to Agreed Order Docket 21304.

Since the Single-Pass technology has previously been implemented, it is the most mature, and it is expected to be the most expedient for design, fabrication (if needed), installation, and final implementation. This does not consider the potential impact of other work which may be underway in T-Farm at time of installation, such as deployment of an interim surface barrier (2026). It is expected that coordination of such other work can be accomplished without appreciable impact on the duration required to deploy active ventilation as an interim leak response action.

See Section 4.8 for remarks on the requirements for interim leak response measures that may be expected to have a total project cost over $50M and the impact of this threshold on practicability with respect to schedule.

4.8 COST AND RESOURCES EVALUATION

As reported for the B-109 document (RPP-RPT-64081), the cost and resources necessary to install and operate any active ventilation system depends on the flow rate capacity determined as necessary for the ventilation train that is to be installed, the extent of worker engagement required to operate it, and the extent of maintenance required to ensure performance as planned.

Considering requirements applicable to the Hanford Site, projects with an expected capital cost exceeding $50M are subject to DOE O 413.3B, 2010, *Program and Project Management for the Acquisition of Capital Assets*. Projects of this scale use a Critical Decision approach that requires years to implement. The duration required for projects of this scale suggest they would not be practicable as an interim leak response because of the time required before these solutions can have an impact on tank conditions.

For projects where the capital costs are expected to be less than $50M, the practicability of incurring cost and utilizing resources to remove water from Tank 241-T-101 by active ventilation can be determined by considering the benefits which would be obtained by its deployment and its impact on the tank waste mission.

Attachment 3 in RPP-RPT-64081 (for Tank B-109), provides an estimate of the cost for deploying active ventilation as an interim response action for a leaking SST. The basis used for that estimate includes actual costs incurred for deploying exhauster POR06 in the form of single-pass ventilation on Tank 241-T-111 and results of recent estimating activities for installing and operating a comparable system on Tank 241-B-109. That estimate concludes that the total project cost for installing a single-pass ventilation system with an exhauster comparable to POR06 and operating it for a period of up to two years as an interim leak response at Tank T-101 may be $18M.

Approaches that require process or technology development, testing to verify operability at scale in a relevant environment, or management of significant amounts of condensate would double the cost as much as $36M as opposed to the simple, single-pass design. Note that costs in excess of $30M require congressional notification in the budget process, which may extend the

timeframe required for initiation of a ventilation system as an interim response. Further, a project of that scale would be expected to have a consequential impact on Hanford's tank waste mission.

5.0 SUMMARY OF PRACTICABILITY EVALUATIONS

As discussed above, the following categories for Single-Pass ventilation have all been evaluated and determined:

- Functionality and feasibility of installation and operations
- Condensate generation and management
- Permitting evaluation
- Active ventilation impacts on tank waste, waste volume, and leak rate
- Waste evaporation rate
- Nuclear safety impacts
- Worker hazards
- As Low As Reasonably Achievable
- Schedule
- Cost and resources

Single-Pass ventilation system provides:

- The shortest length of time to implement and install due to technology readiness and maturity (already used in a similar application for T-111). Re-use of POR06 is available but would require maintenance and perhaps replacement of components to be brought back on-line. (POR06 was last used at T-111 in April 2019 – 5-years of non-use or maintenance.)
- The simplest, most direct, and easiest to both maintain and operate.
- An expected year-round net positive evaporation rate. However, evaporation rates may be suppressed in time of high ambient humidity.
- An effective option with substantial benefit, where cost of deployment is predictable.

6.0 CONCLUSION

Active ventilation of Tank 241-T-101 will likely reduce the quantity of both the full amount of supernatant and an upper portion of the drainable interstitial liquid by removing an estimated 14,900 gallons of water from the tank that may contaminate the environment in a future leak. It will also functionally reduce the rate of potential leakage from this tank by reducing the hydrostatic pressure acting on a leak site. The particular waste profile of 241-T-101 consists of a layer of sludge at its base, and the liquid remaining within the tank after active ventilation would be retained by the sludge, thereby mitigating the effects of any continued leak.

As discussed in this report, discussed in RPP-PLAN-65643, *Single-Shell Tank System Leak Response Plan*, and discussed in Washington State Dangerous Waste Regulations at Chapter 173-303 of the Washington Administrative Code (WAC 173-303), the words “practicable” or “earliest practicable time” are not well-defined. Therefore, for purposes of this study, what constitutes practicable is to be based on its standard, technical meaning. In this context, it is reasonable to determine if something is “practicable” by balancing risks to human health and the environment and a variety of technical and economic factors. In the past, in the context of single-shell tank retrievals, Ecology and DOE have defined practicable “[to] include matters such as risk reduction, facilitating tank closures, costs, the potential for exacerbating leaks, worker safety, and the overall impact to the tank waste retrieval and treatment mission.”

The evaluation in this report demonstrates there are no technical factors that would preclude installation of an active ventilation system in Tank 241-T-101 as a leak response measure. However, deploying an active single-pass ventilation on this tank in any form will require a request for a new emission point permit for the criteria and toxics air pollutants (See Appendix 2) under the site's Air Operating Permit. Anything greater than a passive air exchange of 38 acfm will exceed the *de minimis* amounts and installation will not be practicable and therefore not required. Additionally, exhaust air may be minimally drawn from the cascaded tanks and affect the applicability of a permit that is strictly for Tank T-101.

The overall determination of practicability therefore becomes a cost-benefit analysis that considers risk reduction, cost and schedule for implementation and permitting requirements, and the overall impact to the tank waste retrieval and treatment mission from the diversion of resources to the leak response. The evaluation in this report demonstrates there are no technical factors that would preclude installation of an active ventilation system in Tank 241-T-101 as a leak response measure.

As discussed in Section 4.7 permitting for Toxic Air - *de minimis*, potential radioactive constituents, and dispersion modeling could be simultaneously achieved in 9-12 months.

Based on the data presented in this report, the deployment of a single-pass ventilation as an interim leak response action for Tank 241-T-101 will evaporate water from that tank, reducing the risk to the public and to the environment. This response action could be undertaken in less time and with fewer mission impacts than other potential response actions (e.g., accelerating

retrieval of the tank), and the infrastructure necessary to implement the action (e.g., utilities) is largely in place or readily installed, leading to the conclusion the response is feasible in terms of schedule and cost.

On this basis, the evaluation shows it is feasible to install an active single pass ventilation system on Tank 241-T-101 as an interim leak response action. However, this evaluation concludes that installation of a single-pass ventilation system will create a new emission point under the Hanford Site Air Operating Permit will require a toxic air permit and additional programmatic complexity and schedule. Consistent with Section V.C.1.iii of the Agreed Order, installation will not be required and therefore not pursued.

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APPENDIX 1

ESTIMATING THE AMOUNT OF WATER REMOVABLE FROM 241-T-101 BY ACTIVE VENTILATION

Note: The 241-T-101 waste volumes presented are from the current best basis inventory (BBI) in RPP-RPT-58186, Rev 3, *Derivation of Best-Basis Inventory for Tank 241-T-101*, May 2021. More current ENRAF and LOW measurements are available.

TANK T-101 ESTIMATED WATER REMOVABLE BY ACTIVE VENTILATION

I. TANK T-101 WASTE HISTORY AND CHARACTERISTICS

Additional tank waste transfer information is included in WHC-MR-0132, A History of the 200 Area Tank Farms, LA-UR-97-311, Waste Status and Transaction Record Summary (WSTRS Rev. 4) and tank waste summary reports.

The waste phases and waste types in Table 1 below are based on Revision 4 of the HDW model and process history (LA-UR-96-3860, Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4). Tank 241-T-101 was declared inactive in 1980, identified as an assumed leaker in October 1992, and interim stabilized by supernatant pumping in April 1993 (HNF-SD-RE-TI-178, Single-Shell Tank Interim Stabilization Record). A leak assessment was performed in 2019 and the tank was reclassified as “sound” (RPP-ASMT-62935, Leak Assessment Report for Tank 241-T-101). Tank 241-T-101 was selected for an intrusion evaluation due to an increase in waste surface and interstitial liquid levels in 2012, and the intrusion was confirmed in a March 10, 2014, video (reference RPP-RPT-58239 and discussion TFC-ENG-CHEM-P-57). The combined intrusion water and supernatant sample data from March 4, 1993, make up the supernatant waste phase.

Two sludge types are identified in HDW Rev 4 for 241-T-101, namely, metal waste (MW) sludge at the bottom of the tank, and CWR2 sludge precipitated from supernatant transfers from 1963-72. In addition, the HDW model indicates T2-SltCk solids from the 242-T evaporator precipitated in this tank from 1971 through 1976. Hanford Waste Tank Sluicing History (WHC-SD-WM-TI-302) states sluicing of tank 241-T-101 occurred until December 1956, when the tank was "declared empty.” Therefore, the BBI assessment assumes that there is little or no MW remaining in tank 241-T-101.

The tank 241-T-101 sample-based supernatant density (1.22 g/mL) and weight percent water (71.12 wt %) from the March 1993 are from the grab sample analysis (Sutey 1993). The density and weight percent water have been adjusted for intrusions and evaporation to an effective date of May 1, 2021. The updated supernatant density and weight percent water are 1.02 g/ml and 96.60%. This shows that the supernatant is primarily water available for evaporation and subsequent removal.

Table 1 summarizes current estimates for tank T-101 waste types and volumes.

Table 1. Tank 241-T-101 Best Basis Inventory Source Data

Waste Phase	Waste Type	Available Concentration Data[1]	Volume
Supernatant	T2-SltCk (diluted)	1993 T-101 Grab Sample (P/T101/004)	27 kL (7 kgal)
		T2-SltCk Liquid Template (TS/U204/039)	
		T-101 PCB Liquid Template (TS/T101/004)	
Saltcake Liquid	T2-SltCk	T2-SltCk Liquid Template (TS/U204/039)	44 kL (12 kgal)
		T-101 Liquid PCB Template (TS/T101/001)	
Saltcake Solids	T2-SltCk	T2-SltCk Solids (TS/U204/021)	140 kL (37 kgal)
		T-101 Saltcake Solids PCB Template (TS/T101/002	
Sludge[2]	CWR2	CWR2 Solid Template (TE/U204/098)	140 kL (37 kgal)
		T-101 Sludge PCB Template (TS/T101/003)	
Total Tank[3]			351 kL (93 kgal)

Source: RPP-RPT-58186, Rev 3

Notes:

[1] Vector handles, shown in parentheses, are unique serial identifiers for the vectors used in the BBIM database.

[2] The sludge waste phase includes both solids and interstitial liquid; the sludge liquid volume is estimated to be 24 kL (6 kgal).

[3] The sum of the waste phase volumes in kgal may not exactly match the tank total volume due to rounding.

RPP-RPT-60305, Rev. 03, *Single-Shell Tank Updated Drainable Interstitial Liquid Volumes 2020,* dated November 2021, shows the surface liquid (area) as 81%. A more recent photo with a similarly sized pool surface is shown below from RPP-RPT-65071.

Figure 1. Tank T101 Waste Surface, Riser-005, March 19, 2024

II. T-101 WASTE VOLUME AND DRAINABLE LIQUIDS

RPP-RPT-58239, Fiscal Year 2014 Visual Inspection Report for Single-Shell Tanks, estimated the supernatant pool in 241-T-101 covered approximately 81% of the waste surface in March 2014. At the time of the inspection, the Enraf® measured 43.5 inches, which converts to a total waste volume of 358 kL (95 kgal) using Software Management Plan for Utility Calculation Software Tank Waste Volume Calculator (RPP-PLAN-60585). Solids around the pool appeared to be approximately level with the supernatant. The Enraf was used to perform the liquid depth check during the inspection and RPP-RPT-58239 estimated the liquid depth to be approximately 3.5 to 4 inches below the Enraf. The Enraf is near the edge of the supernatant pool, so the depth of the liquid is potentially deeper elsewhere. An average depth of 4 inches equates to a supernatant volume of 34 kL (9 kgal) (2.750 kgal/in. times 4 inches times 0.81 equals 8.9 kgal) in March 2014.

RPP-RPT-65071, Rev.00, *2024 Leak Assessment Report for Tank 241-T-101,* September 2024 in the attached PowerPoint slideshow says specifically that "from 2014 (the above data) to 2024, the surface level has decreased ~ 1 inch." HNF-EP-0182, Rev 441, *Waste Tank Summary Report for Month Ending September 30, 2024,* reports for Tank T-101 as follows:

> Total Waste – 93 kgal; DIL – 11 kgal; Supernatant Liquid – 7 kgal; Sludge – 37 kgal; Saltcake – 49 kgal; with a solids volume update of 5/1/2021.

The supernatant level has decreased during the last 10 years by approximately 1 inch. As discussed above, the supernatant volume was estimated at 8.9 kgal in 2014. In HNF-EP-0182 with the level decrease of 1 inch as reported in RPP-RPT-58239, the supernatant volume is listed as 7 kgal.

Overall, the Enraf has decreased from 43.5 inches during the inspection video (March 10, 2014) to 42.73 inches as of May 1, 2021. Intrusions appear to have decreased or stopped since 2014 and Enraf decreases are attributed to evaporation. The supernatant waste layer volume as of May 1, 2021 was estimated to be 27 kL (7 kgal) (2.750 kgal/in. times (4 minus 0.77) in. times 0.81 equals 7.2 kgal). The total sludge volume of 140 kL (37 kgal) was calculated from a sludge level measurement collected in the fourth quarter of 1969 (WHC-MR-0132 and LA-UR-96-3860). The BBI assessment identifies the sludge waste type as CWR2.

The remaining waste is believed to be T2-SltCk. The volume of the T2-SltCk layer is estimated to be 184 kL (49 kgal), calculated by difference between the total tank volume and the sludge and supernatant volumes at the time of the 2014 inspection (358 kL minus 34 kL minus 140 kL equals 184 kL). The lower volume estimates of the saltcake layer compared to revisions 0 and 1 of this BBI may be partly due to dissolution of solids by intrusion water. Assuming an average drainable porosity of 0.24 (RPP-RPT-60305, Single-Shell Tank Updated Drainable Interstitial Liquid Volumes - 2020), the volume of T2-SltCk liquid is 44 kL (12 kgal) and the volume of T2-SltCk solids is 140 kL (37 kgal). It was assumed the sludge templates represented both solids and interstitial liquid. As a result, a separate interstitial liquid inventory was not determined for the sludge waste phase. Assuming an average in-tank sludge drainable porosity of 0.17 (RPP-RPT-60305) the volume of sludge liquid is estimated to be 24 kL (6 kgal).

The current total tank volume of 351 kL (93 kgal) is the sum of the sludge, supernatant, and saltcake (140 kL plus 184 kL plus 27 kL equals 351 kL). This is a decrease of 2 kL from the previous BBI update due to evaporation of the supernatant layer covering approximately 81% of the waste surface.

Soil studies (referenced below and used for B-109 saltcake analysis) observed that the depth of effective surface evaporation in the Gobi Desert was about 1-ft with only a small variation for different soil types, clay, loam, and sand). At this depth the evaporation rate decreased to less than 5% of the initial evaporation rate (P. Lehman, 2019, *"Surface Evaporative Capacitance: How Soil Type and Rainfall Characteristics Affect Global-Scale Surface Evaporation,"* Water Resources Research, Vol 55, Issue 1, pp. 519-539).

For an actively ventilated tank, the evaporation rate is controlled by the tank dome space vapor density, atmospheric vapor density, and the ventilation rate. Water moves from the waste surface to the air or dome space. As in soils, initially water rises rapidly to the waste surface by active capillary movement and is drawn into the dome space by active ventilation. The dome space humidity is high and evaporation rate is controlled largely by the ventilation rate. As active ventilation continues the waste surface and dome space get dryer and at some point, the evaporation rate will be controlled by the slow rate of diffusion through the waste. Evaporation will stop when the dome space vapor density is equal to or lower than the atmospheric vapor density. Some evaporation will continue as moisture diffuses to the waste surface and into the dome space, but at a much slower, almost negligible, rate.

Justification for assuming liquid from the top 12 inches of the saltcake was analyzed for B-109 waste. This same justification can be applied to the saltcake from T-101 that has a similar porosity and liquid content.

The following information was analyzed and presented for B-109 (RPP-RPT-64081):

> *Based on BBI waste volume estimates, the B-109 upper waste surface (top 12-in or more) is saltcake, 24% of the waste is removable by active ventilation (based on average saltcake drainable porosity estimates) to a depth of 12-in (based on soil studies showing effective depth), 50% of the surface area is above the ILL and 70% of the liquid is water (Estimated water content of interstitial liquids in B-109); the estimated volume of water, not including dome space water vapor, that would be effectively evaporated from B-109 is about 3 kgal (12-in times 2750 gal/in times 24% times 50% times 70% equals 2,772 gal).*
>
> *Chemistry (OLI) and thermodynamic (COMSOL) models, for the B-109 waste and active ventilation processes, indicate only liquids from about the top 13-in of waste will be removed by active ventilation, and 3 kgal of water or less would be evaporated from the waste. Calculations from OLI show a small decrease in the partial pressure of water for the B-109 liquid compared to water, slightly lowering the amount of water that can be evaporated over time. A highly simplified model for drying was used in COMSOL, treating the B-109 solids and headspace air at the same temperature, and ignoring the effects and limitations from heat transfer. More detailed drying models for porous media exist (e.g., t. Defraeye, 2014, "Advanced Computational Modeling for Drying*

Processes", Applied Energy, 131, p323-344), but generally require additional physical parameters on the waste material itself not available for Hanford's wastes.

In the COMSOL model, the depth of capillary-driven evaporation is estimated based on the assumption that the water vapor fraction immediately above the remaining water is 1, the vapor at the top surface of the solids equivalent to the saturation vapor fraction from the OLI calculation, and the net mass flux of water equivalent to the amount of water that can be carried by the ventilation air. Following this point, the drying process enters the falling rate dictated by diffusion, where the flux is inversely proportion to the depth of dried material. (N. Shorki, P. Lehmann, D. Or, 2008, "Effects of Hydrophobic Layers on Evaporation from Porous Media", Geophysical Research Letters, 35). For ventilation at 1000 standard cubic feet per minute, 50%

relative humidity, and temperature at 30 °C, COMSOL estimates that about 13.2 in, or 3,056 gal, would be evaporated initially through capillary action, drying out the remaining saltcake.

Because the bottom 27-in of waste is sludge, after active ventilation of liquids from the saltcake, most of the remaining liquids are likely held by capillary action and surface tension, estimated to be 24-in above a water table or saturated liquid level for sludge waste; potentially more (RPP-RPT-60305). As a result, although saturated, the sludge is not expected to drain and tank B-109 should not leak after evaporation of liquids from the salt.

APPENDIX 2

CRITERIA AND TOXICS AIR EMISSIONS ESTIMATE TO SUPPORT 241-T-101 VENTILATION PRACTICABILITY DETERMINATION

November 20, 2024 WRPS-2406491

INTEROFFICE MEMORANDUM

WRPS-2406491

Date: November 20, 2024

To: Ruben E. Mendoza, Deputy Manager
Production Operations Engineering

From: Thomas G. Beam, Manager
Environmental Permitting

Beam, Thomas G
Digitally signed by Beam, Thomas G
Date: 2024.11.20 12:56:06 -08'00'

Subject: CRITERIA AND TOXICS AIR EMISSIONS ESTIMATE TO SUPPORT 241-T-101 VENTILATION PRACTICABILITY DETERMINATION

References:
1. TFC-ESHQ-ENV_PP-C-05, Air Quality Program-Permitting for Toxic and Criteria Air Pollutant Emissions Activities.
2. WAC 173-400-110, New source review (NSR) for sources and portable sources.
3. WAC 173-460-150, Table of ASIL, SQER and de minimis emission values

This memorandum reports the results of the Criteria and Toxic Air emission estimate analysis for the tank 241-T-101. This emission analysis was performed using sample data obtained from the TWINs and SWIHDs databases as guided by procedure (Reference 1) and regulation (Reference 2). Data was selected based on data quality and applicability to the project. Due to shared headspace, sample data from T-101, T-102, and T-103 were included in this analysis.

Criteria pollutants were assessed, and estimated emissions compared against the permitting exemption levels as defined in WAC 173-400-110(5), with the results shown in Table 1. A total of 36 toxic air pollutants were reliably identified from tank headspace sampling data. Emissions were calculated for the identified toxic air pollutants and assessed against the WAC 173-460-150 permitting thresholds (Reference 3), with the results shown in Table 2. Table 1 and 2 were evaluated at the maximum exhauster flow to stay below regulatory thresholds, for T-101 this is maximum flow rate is 38 cfm.

This evaluation of estimated emissions indicates that the installation of a ventilation system on tank T-101 will trigger the need to obtain a criteria/toxic air permit from the Washington State Department of Ecology per WAC 173-400-110, unless the maximum exhauster design flow rate (i.e., maximum fan design capacity) remains below 38 cfm.

Please note that independent of this evaluation of potential criteria/toxic air permitting thresholds, a radioactive air emissions license from the Washington State Department Health will be required for the installation of ventilation, regardless of size, in accordance with the requirements of WAC 246-247.

Table 1. Criteria Pollutants Emission Rates and Comparison to Exemption Levels

Compound	CAS #	Emission Rate (g/s)	Emission Rate (lbs/year)	Exemption Level (lbs/year)	Above Exemption?
Nitrogen oxides	10102-44-0	0.00E+00	0.00E+00	4000	No
VOCs	Various	1.33E-04	9.28E+00	4000	No
SO_x (Sulfur oxides)	7446-09-05	0.00E+00	0.00E+00	4000	No
Lead	7439-92-1	0.00E+00	0.00E+00	10	No
Carbon monoxide	630-08-0	0.00E+00	0.00E+00	10000	No
PM-10	NA	5.44E-08	3.78E-03	1500	No
PM-2.5	NA	5.44E-08	3.78E-03	1000	No
Total suspended particulates	NA	5.44E-08	3.78E-03	2500	No
Ozone Depleting Substances, total	NA	2.89E-06	2.01E-01	2000	No

Table 2. Toxic Air Pollutants in Tank 241-T-101

Exhauster Flow Rate (CFM) 38				241-T-101 emissions Emission point evaluation (November 2024)			
Compound	CAS#	SWIHD and TWINS Highest Value (mg/m3)	Emission Rate g/s	Total Unit of Measure Based on Averaging Period (lbs per period)	Averaging Period	Above De Minimis?	% of demin
1,3-Butadiene	106-99-0	0.2146	3.89E-06	2.70E-01	year	Yes	100.00%
N-Nitrosodiethylamine	55-18-5	0.0002	3.26E-09	2.26E-04	year	No	46.22%
N-Nitrosodimethylamine	62-75-9	0.0002	3.26E-09	2.26E-04	year	No	20.59%
Acrylonitrile	107-13-1	0.0043	7.87E-08	5.46E-03	year	No	19.50%
N-Nitroso-N-methylethylamine	10595-95-6	0.0002	3.26E-09	2.26E-04	year	No	17.42%
Mercury, elemental	7439-97-6	0.0030	5.44E-08	1.03E-05	24-hr	No	9.40%
Acetaldehyde	75-07-0	0.2000	3.63E-06	2.52E-01	year	No	8.39%
N-Nitrosodi-N-butylamine	924-16-3	0.0002	3.08E-09	2.14E-04	year	No	8.23%
Acetonitrile	75-05-8	5.0523	9.16E-05	1.74E-02	24-hr	No	7.92%

Table 2. Toxic Air Pollutants in Tank 241-T-101

Exhauster Flow Rate (CFM) 38				241-T-101 emissions Emission point evaluation (November 2024)			
Compound	**CAS#**	**SWIHD and TWINS Highest Value (mg/m3)**	**Emission Rate g/s**	**Total Unit of Measure Based on Averaging Period (lbs per period)**	**Averaging Period**	**Above De Minimis?**	**% of demin**
N-Nitrosopiperidine	100-75-4	0.0002	2.90E-09	2.01E-04	year	No	6.71%
N-Nitrosodi-N-propylamine	621-64-7	0.0002	3.26E-09	2.26E-04	year	No	5.52%
N-Nitrosomorpholine	59-89-2	0.0002	3.26E-09	2.26E-04	year	No	5.27%
1,1,2,2-Tetrachloroethane	79-34-5	0.0041	7.47E-08	5.18E-03	year	No	3.70%
Nitrobenzene	98-95-3	0.0040	7.31E-08	5.07E-03	year	No	2.54%
Naphthalene	91-20-3	0.0037	6.66E-08	4.62E-03	year	No	1.92%
N-Nitrosopyrrolidine	930-55-2	0.0002	3.26E-09	2.26E-04	year	No	1.62%
Formaldehyde	50-00-0	0.0172	3.12E-07	2.16E-02	year	No	1.54%
Ethylene dichloride (EDC, 1,2-dichloroethane)	107-06-2	0.0036	6.60E-08	4.58E-03	year	No	1.48%
Chloroform	67-66-3	0.0039	7.09E-08	4.92E-03	year	No	1.41%
Fluorides (fluoride containing chemicals), NOS	M12	0.1520	2.76E-06	5.24E-04	24-hr	No	1.09%
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	0.0038	6.93E-08	4.81E-03	year	No	0.94%
1,4-Dichlorobenzene	106-46-7	0.0036	6.55E-08	4.54E-03	year	No	0.61%
Acrolein	107-02-8	0.0021	3.74E-08	7.10E-06	24-hr	No	0.55%
Benzene	71-43-2	0.0032	5.78E-08	4.01E-03	year	No	0.40%
Perchloroethylene	127-18-4	0.0041	7.38E-08	5.12E-03	year	No	0.39%
Carbon tetrachloride	56-23-5	0.0038	6.84E-08	4.74E-03	year	No	0.34%
1,4-Dioxane	123-91-1	0.0036	6.53E-08	4.53E-03	year	No	0.28%
Allyl chloride	107-05-1	0.0031	5.68E-08	3.94E-03	year	No	0.28%
Trichloroethylene (TCE)	79-01-6	0.0038	6.82E-08	4.73E-03	year	No	0.28%
1,3-Dichloropropene	542-75-6	0.0036	6.58E-08	4.57E-03	year	No	0.23%
Ethyl benzene	100-41-4	0.0039	7.09E-08	4.92E-03	year	No	0.15%

Ammonia	7664-41-7	0.7077	1.28E-05	2.44E-03	24-hr	No	0.13%

Table 2. Toxic Air Pollutants in Tank 241-T-101

Exhauster Flow Rate (CFM) 38				241-T-101 emissions Emission point evaluation (November 2024)			
Compound	**CAS#**	**SWIHD and TWINS Highest Value (mg/m3)**	**Emission Rate g/s**	**Total Unit of Measure Based on Averaging Period (lbs per period)**	**Averaging Period**	**Above De Minimis?**	**% of demin**
1,1-Dichloroethane (ethylidene dichloride)	75-34-3	0.0036	6.60E-08	4.58E-03	year	No	0.09%
Propionaldehyde	123-38-6	0.0021	3.88E-08	7.38E-06	24-hr	No	0.02%
2-Hexanone	591-78-6	0.0037	6.69E-08	1.27E-05	24-hr	No	0.01%
Methyl alchohol (methanol)	67-56-1	1.6027	2.91E-05	5.52E-03	24-hr	No	0.01%

Mxx CAS number assignments are established for TAP species not identified by CAS number within WAC 173-460-150, but as compound groups. M12 is specifically assigned to “Fluorides (fluoride containing chemicals), NOS”.

Please contact me at (509) 376-9016 if you have any questions or require additional input from environmental permitting to support this effort.

Distribution:
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