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Single-Shell Tank Retrieval Selection and Sequence

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Abstract: This document presents an example single-shell tank (SST) retrieval sequence developed to incorporate the SST retrieval pool list into River Protection Project mission planning. This document was requested by the Washington State Department of Ecology following Hanford Federal Facility Agreement and Consent Order M-45 milestone negotiations.

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SINGLE-SHELL TANK RETRIEVAL SELECTION AND SEQUENCE

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TERMS

BBI	Best-Basis Inventory
CH2M HILL	CH2M HILL Hanford Group, Inc.
Ci	Curies
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
FY	fiscal year
g/mL	grams per milliliter
gal	gallons
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HTWOS	Hanford Tank Waste Operations Simulator
Kgal	kilogallons (1,000 gallons)
LLW	low-level waste
Mgal	million gallons
MT	metric ton
ORP	U.S. Department of Energy, Office of River Protection
PUREX	Plutonium-Uranium Extraction
RPP	River Protection Project
SpG	specific gravity
SST	single-shell tank
TRU	transuranic waste
WIPP	Waste Isolation Pilot Plant (Carlsbad, New Mexico)
WMA	waste management area
WTP	Waste Treatment and Immobilization Plant

1.0 INTRODUCTION

This document identifies the pool of single-shell tanks (SST) to be used for selecting and scheduling the next two years of tank waste retrieval activities and presents the results from a Hanford Tank Waste Operations Simulator (HTWOS) model run named "TPA M-45-04-01 Change Request Case" performed to incorporate SST retrieval pool list into River Protection Project (RPP) mission planning.

This document was prepared as requested by the Washington State Department of Ecology (Ecology) following *Hanford Federal Facility Agreement and Consent Order* (HFFACO) M-45 negotiations (Ecology et al. 2003). Ecology had requested deferral of their review of the *Single-Shell Tank Retrieval Sequence and Double-Shell Tank Space Evaluation* document (RPP-8554) and of completion milestone M-46-01J "Concurrence of Additional Tank Acquisition." This document provides updated information to assess the impact of proposed HFFACO changes and facilitate Ecology completion of the milestone. Space-saving options contributing to the receipt and storage of SST waste were modeled through the end of fiscal year (FY) 2006. The following activities are still ongoing within the double-shell tank (DST) system to provide additional SST storage space:

- Increase the DST Fill Height,
- Concentrate Supernatant Waste to a Higher Density, and
- Use "Restricted" Space in Waste Treatment and Immobilization Plant (WTP) Staged Feed Tanks.

Concurrently, SST retrieval plans have evolved to reduce the required DST space through an increase in the amount of high-curie concentration SST sludge waste retrieved, a reduction of the amount of SST salt waste retrieved, and the use of recycled DST liquids for sluicing. In addition, plans are continuing to demonstrate supplemental treatment processes that avoid the need for DST space, if successfully deployed.

Summary of the HTWOS Case

The HTWOS model simulates waste storage, retrieval, and treatment processes to provide an operating strategy for implementing the RPP mission. Modeling assumptions start with the mission requirements from major agreements and commitments, such as the HFFACO, along with other key assumptions. The HTWOS uses information about waste properties, tank system configurations, desired end states, target milestones, and other parameters associated with particular waste processing scenarios to produce a variety of outputs. These model outputs are used to evaluate the relationship between tank waste retrieval and disposal activities to verify existing plans for accomplishing the RPP mission and for developing future plans.

The baseline version of the HTWOS model is described in the *Tank Farm Contractor Operation and Utilization Plan* (HNF-SD-WM-SP-012, Rev. 5A).

The SST retrieval pool list was incorporated into RPP mission planning by running the baseline version of the HTWOS model with the following modifications:

- Incorporated the SST retrieval pool list recently negotiated with Ecology. The basis for the SST retrieval pool list is provided in Section 2.0.
- Revised plans for increasing the DST fill heights as described in Section 5.1.
- Updated plans for near-term retrievals based on CH2M HILL Hanford Group, Inc. (CH2M HILL) field schedules.
- Revised schedules for new waste receipts from the Plutonium-Uranium Extraction (PUREX) facility, the 300 Area, and T-Plant.
- Incorporated a new approach for estimating settled solids volumes.
- Incorporated changes in the planning for the delivery of waste to supplemental treatment facilities.

2.0 SINGLE-SHELL TANK RETRIEVAL POOL

Selection of the appropriate SSTs to target for retrieval activities requires balancing a variety of objectives and parameters. This section discusses the criteria used to identify candidate tanks and describes the methodology used to develop the tank pool.

2.1 SELECTION FACTORS

The recently completed M-45 negotiations identified primary objectives that are reflected in the primary criteria used to evaluate the SSTs (see draft HFFACO Change Number M-45-04-01 for further details). With the recognition that many different factors are considered when selecting tanks for early retrieval, a set of additional criteria was also identified during the M-45 negotiations to help distinguish between tanks that perform similarly in the primary criteria.

Consistent with Appendix I of draft HFFACO Change Number M-45-04-01, the primary objectives are to maximize the reduction of short and long term risk to human health and the environment and to optimize waste feed so as to maintain efficient WTP operations, as further described in the following criteria summaries:

2.1.1 Human Health And Environmental Risk Reduction

Radioactive Concentration – The radioactivity per gallon of tank waste is a way of measuring the short term risk and as used here represents the current estimate of radioactive concentrations in the SSTs. The most effective method for reducing the curie content within the SST system is to retrieve those tanks that have the highest curies per gallon (Ci/gal) ratio. Retrieving tanks with the highest activity per gallon will provide for optimum curie content reduction.

Groundwater Risk – Groundwater risk is a way of measuring the long term risk and as used here is based on increased cancer risk for a groundwater ingestion path (see RPP-8554 for further details). Selected isotopes have a greater risk to the groundwater because of their propensity to migrate through soils and into the groundwater. These contaminants of concern comprise the significant portion of the risk to groundwater and include ^{14}C, ^{79}Se, ^{99}Tc, ^{129}I, and ^{238}U. Retrieving the tanks that have the greatest inventory of these isotopes will, therefore, provide maximum groundwater risk reduction.

Airborne Risk – Airborne risk is another way of measuring long term risk and as used here is focused on a post-well driller intruder scenario (see RPP-8554 for further details). Similar to groundwater, some isotopes contribute more than others to airborne exposure. There are 21 isotopes that comprise the significant portion of the airborne risk which is summarized by the Best-Basis Inventory (BBI) for each SST. The 21 isotopes include: ^{94}Nb, ^{126}Sn, ^{232}Th, ^{238}U, ^{237}Np, ^{236}Pu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{242}Am, ^{243}Am, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, and ^{248}Cm. Retrieving the tanks that

have the greatest inventory of these isotopes will therefore provide maximum airborne risk reduction.

2.1.2 Maintain Efficient WTP Operations

Balance WTP Feed – The WTP is being designed to process both high-level and low-activity wastes. Providing a balance of high-level and low-activity waste feeds in a way that optimizes WTP operations has been identified as a primary criterion for tank selection in Appendix I, Section 2.1.2 of the M-45-00 milestone. Previous life-cycle mission evaluations such as those in the *River Protection Project System Plan* (ORP-11242) identified a potential for "starving" the high-level melter operations because of insufficient staged sludge available in the early years of operations. It is, therefore, necessary to identify SSTs for early retrieval that can sufficiently provide the WTP with a balanced feed.

Shorten WTP Mission – SST wastes that could be retrieved, treated, and disposed without requiring WTP processing potentially reduces the volume of feed to the WTP, shortens the WTP mission, simplifies the task of balancing WTP feed, and, therefore, provides for more efficient use of the WTP facilities. Tanks identified as potential transuranic (TRU) packaging or supplemental treatment demonstration candidates fall into this category. Choosing to retrieve these tanks early in the sequence has the added benefit of requiring little, if any, DST space prior to the start up of the WTP.

Additional factors identified in Appendix I of draft HFFACO Change Number M-45-04-01 that balance the primary factors discussed above include:

WMA Closures – Early closure of an entire waste management area (WMA) is a concept highlighted during recent HFFACO negotiations. The concept involves retrieving all of the SSTs within a WMA which then allows closing the supporting systems and ancillary equipment leading to closure of an entire WMA. This has the advantage of providing tangible closure progress while waiting for the WTP to become operational. Retrieving all tanks within a selected WMA (for example, all of the C-Farm tanks) supports the WMA closure concept.

Optimize DST Volume – DST space is limited until the WTP becomes operational, and therefore, early SST retrievals must be chosen to make optimal use of the limited DST space. SST retrievals resulting in the least amount of DST space used are preferred when the other factors are considered nearly equal.

Resource Leveling and Infrastructure Utilization – Tank retrieval involves unique equipment, infrastructure support and well trained crews operating in close coordination with overall tank farms operations and upgrade projects. The complexity of moving equipment and retraining crews to new areas suggests that significant efficiencies may be gained by retrieving SSTs in the same area using the same primary and infrastructure equipment that was used for the higher priority tanks. The schedule and resource

limitations may suggest that in some cases it makes operational sense to retrieve tanks that may not necessarily rank high in the other factors.

2.2 METHODOLOGY

First, an evaluation of all SSTs against the primary selection criteria was performed. BBI data were collected for all SSTs and then sorted and ranked for each of the three short term and long term risk reduction categories (radioactive concentration, groundwater risk, and airborne risk). While the efficient WTP operations criteria (balance WTP feed and shorten WTP mission) cannot be numerically ranked, specific tanks were identified that met the objective of the criteria. Tanks with significant high level sludge quantities were identified as meeting the balance WTP feed criteria. Tanks that were candidates for direct TRU packaging were identified as meeting the shorten WTP mission criteria.

Then the tanks were evaluated against the additional criteria (WMA closure, optimize DST volume, and resource leveling and infrastructure utilization). The SSTs were numerically ranked by their estimated DST volume needed for storage. Tanks that could be grouped together based on estimates of a common use of resources or equipment were identified as meeting the resource leveling and infrastructure utilization criteria. When all of the tanks in a defined WMA ranked high in most of the other categories they were identified as meeting the WMA closure criteria.

An initial tank screening was completed to identify tanks ranked in the top 50 of each ranked category, and identify tanks that met the criteria for the other non-ranked categories. It should be noted that because the demonstration bulk vitrification system is only planning on a partial retrieval of tank S-109 and full retrieval or near term tank closure actions are not planned, it was not included in the tank pool. All SSTs were identified in a matrix with the eight selection factors to develop a visual image of the selected tanks.

Tank selection was then adjusted to provide a balance of tanks ranked high in the environmental risk reduction factors and the qualitative operational factors. As an additional input, the logistic considerations (i.e., technical complexity, availability of transfer routes) associated with retrieving an entire waste management area were compiled. This information can be found in Table 2-1. Hanford Tank Waste Operations Simulator (HTWOS) runs were completed to validate that the bulk of the retrievals were logistically achievable and effectively used the available DST space. The tank pool data were then compiled in graphical form to provide a visual tool that helps distinguish between preferred and non-preferred tank groupings. To simplify the visual optics, a "star" was used to distinguish a group of tanks where more than half the tanks in that grouping ranked in the top 50 (or met criteria for non-ranked factors) for each factor considered. This "Star Chart" which represents the proposed tank pool is presented in Figure 2-1. Appendix A contains the complete list of SSTs and their relative ranking against the four quantitative selection factors.

2.3 SUMMARY

A review of the SST retrieval pool reveals a balanced mix of tanks that optimizes early risk reduction, provides for early closure of an entire Waste Management Area, and allows for efficient use of resources and common retrieval systems. Additionally, there are enough "extra" tanks to provide the flexibility to support a robust strategic plan that accommodates differences in actual versus planned DST available space, retrieval technology effectiveness, or unforeseen operational restrictions.

Table 2-1. Logistic Considerations for Single-Shell Tank Retrieval. (3 Sheets)

WMA	Physical Challenges / Complexity	Comments
A/AX	A/AX WMA is unique due to the large number of air-lift circulators in the SSTs. Air-lift circulators were originally installed to cool the high temperature high-level waste. These air-lift circulators make retrieval challenging for the following reasons: • About one-half the tanks are assumed to have leaked. MRS/Vacuum retrieval technologies are identified for tanks assumed to have leaked. Both the MRS (with in-tank vehicle) and the vacuum system would be very difficult to operate in and around the air-lift circulators. The current technologies available for deployment may not be effective in retrieving these tanks assumed to have leaked. Additional technology development would be needed to effectively retrieve the waste. • For sound tanks, modified sluicing is the technology of choice. The air-lift circulators would cause many shadowing effects where the sluice nozzles would not be able to effectively mobilize the waste. In addition, the A/AX WMA SSTs have flat bottoms. When a liquid is used to mobilize/dissolve the waste, there is no slope that would cause the waste to flow to a central point where a pump intake could be located. This effect would likely result in the use of high quantities of water to retrieve the last residuals. The A/AX WMA SSTs are located within a short distance of DST receiver tanks; however, transfer routing, and infrastructure requirements have not been thoroughly evaluated.	The tanks assumed to have leaked in A/AX WMA may not be retrievable given our current set of technologies. Significant investment would be required to retrieve this entire WMA. Selected tanks could be chosen based on ability to use currently demonstrated retrieval technology.

Table 2-1. Logistic Considerations for Single-Shell Tank Retrieval. (3 Sheets)

WMA	Physical Challenges / Complexity	Comments
B/BX/BY	With the exception of the TRU or potential TRU tanks the logistics of setting up transfer routes from these tank farms to a DST receiver tank are considered impractical in the next two years. The current lack of compliant transfer piping and the physical separation from operational DST systems necessitates an infrastructure investment that is beyond the scope of work budgeted through the end of FY 2006.	Except for TRU tanks, retrieval not considered a prudent use of limited resources through the end of FY 2006.
C	C-Farm presents an opportunity to use the three main retrieval technologies (vacuum retrieval, modified sluicing, and mobile retrieval system) while utilizing the completed project W-320 piping in addition to some new hose-in-hose transfer lines to transfer retrieved contents to the DST system. The large technical challenge is to develop a retrieval system that minimizes DST space by utilizing supernatant recycle water instead of fresh water as the retrieval/transfer medium.	Best opportunity for early WMA closure. Provides sludge and high-level waste feed needed to support early years of WTP operations. Many tanks rank high in the curie/volume category thus maximizing the curies retrieved in the limited DST volume.
S/SX	The infrastructure needed to transfer from S-Farm to the DST system has been installed and used for the retrieval of tank S-112. Additional S-Farm retrievals could utilize the same equipment, however many of the S-Farm tanks are high volume and would consume a significant amount of DST space. The SX-Farm has several tanks with higher concentrations of radionuclides than our current suite of retrievals. These high-activity tanks could drive the need to revise retrieval designs to provide more shielding and related infrastructure. A transfer line from SX-Farm to SY-DSTs would be required. The cross-site transfer system is currently not configured to handle high volumes of sludge waste. Given this limitation, and the fact that the cross-site slurry line is not operable, the sludge wastes in the SX-Farm would need to be accumulated in the SY-DST system. The cross-site slurry transfer system can be operable after the WTP starts up and waste in tank AN-104 is retrieved and transferred to the WTP.	Retrieval logistics are simplified but large retrieval volumes limit number of tanks that can be retrieved prior to WTP startup.

Table 2-1. Logistic Considerations for Single-Shell Tank Retrieval. (3 Sheets)

WMA	Physical Challenges / Complexity	Comments
T	With the exception of the TRU and potential TRU tanks, a new transfer system and possibly a Waste Receiver Facility would need to be built to transfer sludge waste from T-Farm to the SY-DST system. This long-distance replacement transfer system has not been fully evaluated. The cross-site transfer system is currently not configured to handle high volumes of sludge waste. Given this limitation, and the fact that the cross-site slurry line is not operable, the sludge wastes in the T-Farm would need to be accumulated in the SY-DST system. The cross-site slurry transfer system can be operable after the WTP starts up and waste in tank AN-104 is retrieved and transferred to the WTP.	Except for TRU tanks, retrieval not considered a prudent use of limited resources through the end of FY 2006.
TY/TX	The logistics of setting up transfer routes from the TY or TX tank farms to a DST receiver tank are considered impractical in the next two years. The current lack of compliant transfer piping and the physical separation from operational DST systems necessitates an infrastructure investment that is beyond the scope of work budgeted through the end of FY 2006.	Retrieval not considered a prudent use of limited resources through the end of FY 2006.
U	The hose-in-hose transfer line (HIHTL) to be installed between U-Farm and the SY-DST system during FY 2004 has a three year service life with a potential for some extension. If all of the U-Farm tanks cannot be retrieved within this time period, the HIHTL will require replacement. The solubility and dissolution rate of all U-Farm saltcake has not been established with lab testing. The cross-site transfer system is currently not configured to handle high volumes of sludge waste. Given this limitation, and the fact that the cross-site slurry line is not operable, the sludge wastes in the U-Farm would need to be accumulated in the SY-DST system. The cross-site slurry transfer system can be operable after the WTP starts up and waste in tank AN-104 is retrieved and transferred to the WTP.	Opportunity to use the vacuum retrieval system once the C-200 retrievals are completed. Contains six cask loads of experimental fuel elements, shroud tubes, and samarium poison ceramic balls which complicate retrieval technology selection.

Figure 2-1. Single-Shell Tank Retrieval Pool Selection Criteria.

	Short & Long Term Risk Reduction			Efficient WTP Operations			DST Space Utilization	
Tank	Curies per Gallon	Ground Water Risk	Airborne Risk	Balance WTP Feed	Shorten WTP Mission	Resource Leveling/ Infrastructure	Optimize DST Volume	WMA Closure
A-102 A-106	☆		☆			☆	A-102	
AX-101 AX-102 AX-103 AX-104	☆	☆	☆			☆	AX-102 AX-104	
B-201 B-202 B-203 B-204					☆		☆	
C-101 C-102 C-103 C-104 C-105 C-106 C-107 C-108 C-109 C-110 C-111 C-112 C-201 C-202 C-203 C-204	☆		C-101 C-102 C-103 C-104 C-105 C-107	☆		☆	C-106 C-111 C-201 C-202 C-203 C-204	☆
S-102 S-103 S-105 S-107 S-112	S-107	☆	☆					
SX-101 SX-105 SX-106 SX-108 SX-110 SX-115	☆	SX-101 SX-105 SX-106	☆			☆	SX-115	
T-104 T-110 T-111 T-112 T-201 T-202 T-203 T-204					☆		☆	
U-112 U-201 U-202 U-203 U-204	U-112					☆	☆	

☆ indicates more than half the tanks in a group are ranked in the top 50 for the selection criteria
Individual tank listing indicates the specified tank is ranked in the top 50 for the selection criteria

3.0 SINGLE-SHELL TANK RETRIEVAL SEQUENCE

Eighteen of the SST retrieval pool tanks, listed in Figure 2-1, are identified as the "committed tanks." This term means that there are HFFACO milestones satisfied by completing the retrieval of waste from these tanks. The HFFACO milestones for the committed tanks are listed in Table 3-1. The committed tanks include tanks S-102 and S-112, and all of the C-Farm SSTs and the retrieval of waste from those tanks is projected to be completed by the latest due date; September 30, 2006. The information in Table 3-1 is from draft HFFACO Change Number M-45-04-01.

Table 3-1. HFFACO Milestones for the Committed Tanks (Draft).

Tank	Milestone Number	Milestone Title	Milestone Due Date
C-Farm	M-045-00B	COMPLETE SPECIFIED "NEAR TERM" SST WASTE RETRIEVAL AND INTERIM CLOSURE ACTIVITIES, TO RESULT IN THE RETRIEVAL OF ALL TANK WASTES IN WMA-C SSTS PURSUANT TO THE AGREEMENT CRITERIA IN M-45-00.	9/30/2006
S-112	M-045-03C	COMPLETE FULL SCALE SALTCAKE WASTE RETRIEVAL TECHNOLOGY DEMONSTRATION AT SINGLE-SHELL TANK S-112.	3/31/2005
S-102	M-045-05A	COMPLETE INITIAL WASTE RETRIEVAL FROM TANK S-102.	3/31/2005

Table 3-2 provides an example retrieval sequence for SST waste retrievals through the end of September 2006. This time period covers the retrieval of the committed tanks. The retrieval sequence provided in Table 3-2 is referred to as an example sequence because it was chosen to demonstrate the viability of retrieving the tank pool tanks. In accordance with draft HFFACO Change Number M-45-04-01, "the pool of tanks selected by this document will be used as the starting point for selecting and scheduling the following two years' tank waste retrieval activities". The actual list of tanks to be retrieved during each year will be agreed to annually via a separate document.

Wastes are projected to be retrieved from 31 of the 50 SST retrieval pool tanks by September 30, 2006. Wastes are projected to be retrieved from another 13 of the SST retrieval pool tanks by the end of September 2008. Wastes from the remaining six SST retrieval pool tanks are projected to be retrieved later in the RPP mission because of transfer or operational constraints or in deference to other mission goals. In addition, a limited quantity of waste is projected to be retrieved from one tank not on the pool list (tank S-109) for feed to a demonstration of bulk vitrification as a candidate supplemental treatment technology.

Table 3-2. Example Single-Shell Tank Retrieval Sequence.

Order[1]	SST	Retrieved To	Start Date	End Date	Current Waste Volume[2] (Kgal)	Projected DST Volume Impact (Kgal)
1	C-106			Completed		
2	S-112	SY-102	9/28/2003	7/18/2004	204[3]	2,000
3	C-203	AN-106	6/22/2004	7/4/2004	3	37
4	C-202	AN-106	7/4/2004	7/8/2004	1	12
5	S-102	SY-102	7/10/2004	1/10/2005	438	1,500
6	C-201	AN-106	7/12/2004	7/16/2004	1	12
7	C-204	AN-106	7/19/2004	7/27/2004	2	24
	S-109[4]	SY-102 ST Demo	2/1/2005 6/30/2005	2/8/2005 12/26/2005	533	100 None
8	C-103	AN-106	4/10/2005	5/18/2005	72	171
9	C-102	AN-101	6/9/2005	11/20/2005	316	418
10	U-201	SY-102	6/15/2005	6/20/2005	4	40
11	C-105	AN-106	6/19/2005	8/27/2005	132	232
12	U-202	SY-102	7/2/2005	7/7/2005	4	40
13	U-203	SY-102	7/19/2005	7/24/2005	3	40
14	U-204	SY-102	8/8/2005	8/12/2005	3	30
15	B-201	TRU	8/19/2005	8/29/2005	30	None
16	B-202	TRU	9/12/2005	9/22/2005	29	None
17	B-203	TRU	10/5/2005	10/22/2005	52	None
18	C-109	AN-106	10/28/2005	12/1/2005	64	164
19	B-204	TRU	10/31/2005	11/17/2005	51	None
20	T-201	TRU	12/13/2005	12/23/2005	31	None
21	C-101	AN-101	12/21/2005	2/15/2006	88	247
22	C-112	AN-106	1/2/2006	2/26/2006	104	204
23	T-202	TRU	1/10/2006	1/17/2006	21	None
24	T-203	TRU	2/2/2006	2/14/2006	37	None
25	T-204	TRU	2/25/2006	3/9/2006	37	None
26	T-111	TRU	3/9/2006	8/11/2006	447	None
27	C-110	AN-101	3/16/2006	4/25/2006	178	397
28	C-107	AN-106	3/26/2006	8/2/2006	248	348
29	C-104	AY-101	5/19/2006	9/30/2006	259	359
30	C-111	AN-101	5/26/2006	7/7/2006	58	197
31	C-108	AN-106	8/17/2006	9/21/2006	66	166

Notes:

1. Retrieval ordering numbers are assigned only to SST retrieval pool tanks.
2. Data from HNF-EP-0182.
3. The retrieval of waste from tank S-112 is currently in progress.
4. The initial retrieval of waste from tank S-109 removes Cs from the interstitial liquid leaving a low-Cs fraction in the tank and sends 100 Kgal of waste to the DST system. The second retrieval delivers 300 MT of Na to a bulk vitrification demonstration facility in ~ 690 Kgal of retrieved waste. The remaining waste is retrieved after October 1, 2006.

4.0 DOUBLE-SHELL TANK SPACE OPTIONS

Current estimates indicate that approximately 6.7 Mgal of DST storage capacity are needed for the waste retrieved from SSTs designated in the Retrieval Pool through FY 2006. The DST space-saving efforts are addressed as modeling assumptions and described in Section 5.0. This section describes the DST space savings options employed to meet HFFACO milestone M-46-21.

In 2001, the *Tank Space Options Report* (RPP-7702) presented options that were reviewed for the purpose of alleviating a DST waste storage capacity shortfall. Eight options were identified that had the potential for increasing DST waste storage capacity an additional 5 to 10 Mgal. The study reflected a qualitative analysis conducted to identify promising options. The study pointed out that implementing the options would require more study to establish feasibility, enhance cost estimates, and understand the operational impacts. The options identified in the *Tank Space Options Report* (RPP-7702) were revisited in the *Integrated Mission Acceleration Plan* (IMAP) (RPP-13678). During the two years between preparation of the *Tank Space Options Report* and the IMAP, several significant changes have occurred: SST retrieval plans had accelerated, the WTP schedule and capacity were modified, and supplemental treatment of SST waste was being considered. The IMAP recognized that DST space represented a significant risk to accelerating the RPP mission, and several DST space savings options were targeted for action to support SST waste retrieval and closure. The IMAP recommended space-saving options were:

1. Increased DST fill height,
2. Maintain reserve emergency space compliant with DOE Order 435.1,
3. Concentrate supernatant waste to 1.41 specific gravity (SpG),
4. Bypass DSTs for retrieval of selected SST waste to supplemental processing,
5. Concentrate supernatant waste to maximum SpG,
6. Use restricted DST space and
7. Retrieve and package DST TRU waste.

The model results of this report include the space associated with ongoing field and engineering efforts to implement space savings options. The discussion below addresses where additional DST space could be obtained beyond current model assumptions.

4.1 INCREASE DOUBLE-SHELL TANK FILL HEIGHT

For DSTs located in the AN, AP, AW, and SY Tank Farms, the normal tank fill height is 416 inches (1,144 Kgal), as currently established in *Operating Specifications for Double-Shell Storage Tanks* (OSD-T-151-00007). Fill height exceptions have been approved for tanks AP-102, SY-102, and AW-102 by specific process direction. The existing 416-inch operating limit provides a 6-inch margin below the design basis waste level limit of 422 inches. The

422-inch limit was based on seismic calculations performed in the 1980s, when 422 inches was the maximum waste level used in the calculations. In addition, fill heights for tanks in AY and AZ Tank Farms are constrained by design to 364 inches each (1,001 Kgal).

The recommended fill height is anticipated to be 449 inches. Raising the fill height in AP-Farm tanks will provide an additional 728 Kgal of DST storage capacity. The increased fill height is expected to be implemented in FY 2005. It is possible that tanks in SY, AN, and AW tank farms could store waste above the 416-inch level. However, constraints such as existing gas generating waste, original tank construction/testing methods, and proof of tank integrity are considered technically and/or economically impractical to overcome in the SY, AN, and AW tank farms at this time.

4.2 MAINTAIN RESERVE EMERGENCY SPACE COMPLIANT WITH DOE ORDER 435.1

DOE Order 435.1 requires that space equivalent to the largest single vessel in a waste storage or processing system is available for emergency waste storage. Through FY 2002, 2.28 Mgal of tank space had been reserved for emergency storage. The 2.28 Mgal had historical roots derived from separate tank space needed for aging and non-aging waste. With discontinued operation of PUREX, the need for maintaining separate space for both aging and non-aging waste is no longer necessary. Later, separate emergency space was set aside for WTP and tank farm waste. In FY 2003, an agreement was reached between the U.S. Department of Energy, Office of River Protection (ORP), the Tank Farm Contractor, and the WTP Contractor on Interface Control Document 19 (24590-WTP-ICD-MG-01-019) to maintain just 1.14 Mgal of distributed DST space for emergency storage. The emergency capacity is modeled to increase to approximately 1.24 Mgal when the DST fill height is raised. In May 2003, the *Double Shell Tank Emergency Pumping Guide* (HNF-3484) was updated and issued. These actions have allowed approximately 1.14 Mgal of DST space to be available for SST retrieval. This initiative is considered complete, and no additional storage space is expected to be made available through this initiative.

4.3 CONCENTRATE SUPERNATANT WASTE TO A HIGHER DENSITY

In recent years, tank waste concentration in the 242-A Evaporator was limited to a SpG of 1.41 g/mL. This SpG limit reduced the potential that flammable gas could become trapped in the stored waste and result in periodic flammable gas release events. In actual practice, evaporator campaigns had stopped short of this limit to ensure that waste was not concentrated above this SpG limit.

Recently, modeling tools have been developed that can better predict the potential for creating flammable gas conditions from the solids and concentrated supernatant within a tank (RPP-10006). Laboratory boil down tests and tank-by-tank assessments allow improved understanding of the waste behavior and higher waste concentration in the evaporator. For example, laboratory work conducted for the second FY 2003 evaporator campaign (03-02) showed that a final density of 1.47 g/mL was acceptable for that waste and the associated storage conditions. The evaporator campaign was operated at this higher SpG target. For modeling

performed in this report, wastes are concentrated up to 1.47 SpG. Evaporator campaigns 03-03, 03-04 and 04-01 have concentrated wastes to 1.46, 1.42, and 1.43, respectively. Facility and process upgrades are ongoing to improve evaporator reliability, concentration of the waste, transfer of waste slurries and storage of waste solids.

4.4 BYPASS DOUBLE-SHELL TANKS FOR SELECTED SINGLE-SHELL TANK RETRIEVALS

Direct retrieval of SST waste to supplemental waste processing will bypass the DST system and thereby avoid the need for additional DST space. SST waste scheduled for accelerated retrieval could go directly to supplemental treatment. In this report, it is assumed that waste from four B-200 series tanks, four T-200 series tanks, and tank T-111 is sent directly to transuranic-contact handled and low-level waste (LLW) treatment processes, effectively eliminating the need for the DST system to store this waste. This option is currently constrained by the U.S. Department of Energy (DOE) policy decisions. The TRU wastes will be retrieved only after the Waste Isolation Pilot Plant (WIPP) permitting issue is resolved and Ecology issues its permit of the TRU packaging facility.

4.5 USE "RESTRICTED" SPACE IN WASTE TREATMENT PLANT STAGED FEED TANKS

Currently, 13 DSTs contain waste feed that has been designated as staged waste feed for the WTP. These wastes have been sampled, for testing and analysis by the WTP contractor to assess pretreatment and vitrification processes. The ORP had directed the Tank Farm Contractor to maintain the waste in these tanks under configuration control (letter 00-ORP-79/0003897). This "restricted" space consists of available tank freeboard above the waste that has already been characterized as feed for the WTP. Concentrating and/or backfilling these tanks could potentially affect the existing characterization of the WTP feed. ORP has recently agreed to a set of controls to be used for managing the composition of the waste feed to the WTP and use the storage capacity to the maximum extent possible (letter CH2M-0304844). The current model reflects consolidation of waste in tank AY-102 with tank AP-101 but has not taken full advantage of "Restricted" space because of constraints from buoyant gas displacement, chemical compatibility, and logistics.

4.6 RETRIEVE AND PACKAGE DOUBLE-SHELL TANK TRANSURANIC WASTE

Processing the TRU wastes currently stored in DSTs and separately disposing the material at WIPP before startup of the WTP was envisioned to make DST space available for SST waste retrieval. This option is currently constrained by DOE policy decisions, as well as the high degree of technical risk associated with remote handled TRU processing. This option is not currently being pursued because of these policy and technical constraints for deployment prior to 2006. It is possible that unused headspace in tanks AW-103 and AW-105 could be reconsidered for use.

5.0 DOUBLE-SHELL TANK SPACE EVALUATION

This section describes how much DST space could be made available to support SST retrieval. Figure 5-1 shows how the total DST space is used out through October of FY 2008. There is sufficient space in the DST system to support retrieval of waste from the committed tanks as can be seen in Figure 5-1. Table 5-1 provides the definition of the different space allocation categories used in Figure 5-1. The space saving options implemented or assumed to be implemented to provide space for the committed tanks are discussed below, and Section 4.0 provides a further discussion of the background and status of each of the options.

5.1 INCREASE DOUBLE-SHELL TANK FILL HEIGHT

The maximum fill levels in the AP-Farm DSTs were assumed to be increased from 416 inches (1,144,000 gallons) to 449 inches (1,235,000 gallons) in FY 2005. Design evaluation, records evaluation, and Ultrasonic Testing will confirm by November 1, 2004 that fill heights in AP-Farm DSTs can be increased. Actual use of the increased space will be managed through "In-Process Tests" performed during transfers. This change provides an additional 728 Kgal of DST space.

5.2 MAINTAIN RESERVE EMERGENCY SPACE COMPLIANT WITH DOE ORDER 435.1

The emergency space requirement was increased from about 1.1 Mgal to about 1.2 Mgal when the AP-Farm tank fill levels are increased resulting in a space penalty of about 100 Kgal. The major change in the emergency space requirement (from about 2.3 Mgal to about 1.1 Mgal) was implemented in FY 2003.

5.3 CONCENTRATE EXISTING SUPERNATANT WASTE TO A HIGHER DENSITY

The 242-A Evaporator is operated to concentrate waste to a SpG of 1.47. About 7.8 Mgal of dilute waste was modeled as being sent to the 242-A Evaporator with about 3.5 Mgal of water removed to make DST space for retrieving waste from the committed tanks.

5.4 BYPASS DOUBLE-SHELL TANKS FOR SELECTED SINGLE-SHELL TANK RETRIEVALS

Approximately 1 Mgal of SST waste was assumed to be retrieved and sent to supplemental treatment processes effectively bypassing the DST system, reducing the demand for DST space by about 2 Mgal. About 230 Kgal of waste from tank S-109 was assumed to be retrieved and delivered to a demonstration of bulk vitrification technology reducing the DST space demand by about 700 Kgal. And, about 730 Kgal of waste was retrieved from the B-200 and T-200 series SSTs, and from tank T-111 and delivered to a contact-handled Transuranic (TRU) sludge packaging facility reducing the DST space demand by about 1.2 Mgal based on retrieved waste

volumes reported in an earlier version of the *Tank Farm Contractor Operation and Utilization Plan* (HNF-SD-WM-SP-012, Rev. 4B).

Figure 5-1. Total Double-Shell Tank Volume.

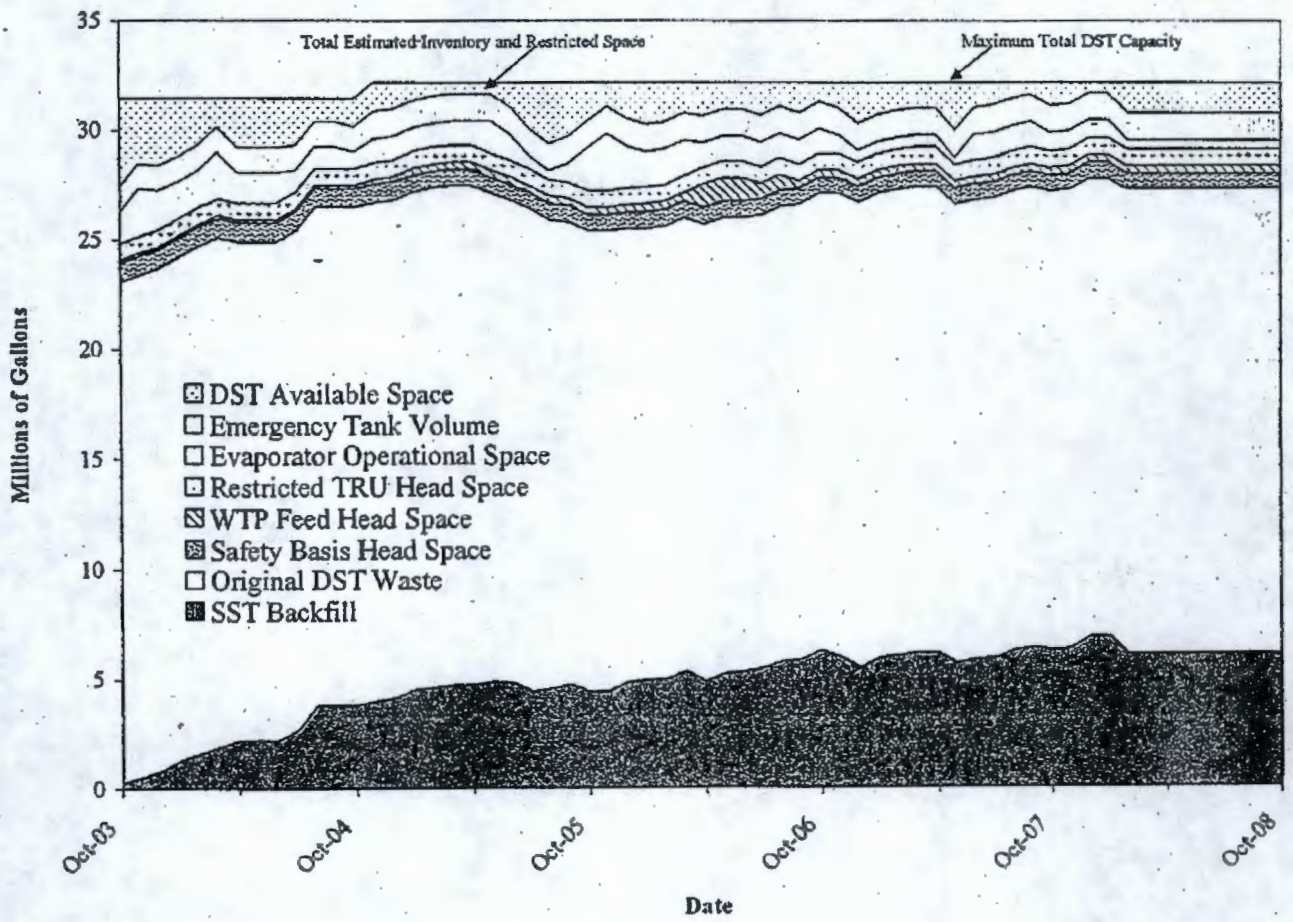

Table 5-1. Double-Shell Tank Space Allocation Criteria.

Category	Criteria
DST Available Space	Unallocated space (i.e., the leftover space).
Evaporator Operational Space	Space above waste in tanks used to support 242-A Evaporator operation. This includes tank AW-102, the bottoms receiver, and any DST used to receive or stage (sample) dilute waste to the evaporator.
Emergency Tank Volume	1.235 million gallons of available space that could be used to receive waste in the event of a leaking DST or emergency returns from the WTP[1].
Restricted TRU Space	Space above the TRU solids in tanks AW-103 and AW-105.
WTP Feed Head Space	Space above waste specifically identified as an early WTP feed source or in tanks used to deliver feed to the WTP throughout the whole mission[2].
Safety Basis Head Space	Space in tanks that cannot be used because of a safety issue associated with the waste[3].
Original DST Waste	Waste in the DST system before July 2003.
SST Backfill	SST waste retrieved into the DST system after June 2003.

Notes:

1. Emergency space does not need to be associated with a specific tank but may be distributed throughout the DST system.
2. Tanks AN-102, AN-107, and AY-102 are allocated to this category. Other DSTs will be allocated to this category when wastes are staged for compliance verification sampling or when the tank is filled with waste before delivery as feed to the WTP.
3. The Category A tanks are allocated to this category; AN-103, AN-104, AN-105, AW-101, and SY-103. They will be re-allocated to the WTP Feed Head Space category when the supernatant is decanted as part of staging the waste as WTP feed.

DST	double-shell tank
SST	single-shell tank
TRU	transuranic
WTP	Waste Treatment and Immobilization Plant

5.5 USE "RESTRICTED" SPACE IN WASTE TREATMENT PLANT STAGED FEED TANKS

Waste in tank AP-101 was assumed to be removed in about August 2005 and concentrated in the 242-A Evaporator, and then combined with high-level waste in tank AY-102. This frees tank AP-101 for storing retrieved SST waste, making about 1.2 Mgal of DST space available. Approximately 1.4 Mgal of head space are available in 11 DSTs, which was formerly identified as "restricted" head space above WTP feed. About 600 Kgal of this space cannot be used because of safety basis issues with the waste (tanks AN-103, AN-104, AN-105, and AW-101), because of waste chemistry issues (tanks AN-102 and AN-107), because it us associated with DST TRU wastes (tank AW-103), and because of operational constraints (tanks AP-104, AZ-101, and AZ-102). The approximately 800 Kgal of head space in tank AY-101 was used to retrieve wastes from tank C-104.

5.6 RETRIEVE AND PACKAGE DOUBLE-SHELL TANK TRANSURANIC WASTE

The head space above the TRU waste in tanks AW-103 and AW-105 is assumed not to be available to support SST waste retrieval. There are approximately 770 Kgal of head space above the wastes in those two tanks.

6.0 REFERENCES

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APPENDIX A.

SINGLE-SHELL TANK RISK RANKING

Table A-1. Tank Ranking by Data Category. (4 Sheets)

Tank	Rank by Ci/gal	Rank by Groundwater Risk	Rank by Airborne Risk	Rank by Estimated DST Space Used (least to greatest)
A-101	49	25	46	106
A-102	24	74	42	35
A-103	58	49	57	108
A-104	2	97	16	37
A-105	4	60	6	41
A-106	13	62	9	67
AX-101	40	43	55	123
AX-102	10	104	58	34
AX-103	16	48	20	61
AX-104	1	58	14	25
B-101	11	102	13	60
B-102	128	132	143	32
B-103	127	124	114	45
B-104	114	84	106	93
B-105	124	110	118	121
B-106	113	105	127	53
B-107	75	88	68	75
B-108	129	122	141	62
B-109	27	113	122	82
B-110	109	82	78	3
B-111	46	55	74	4
B-112	108	94	144	29
B-201	143	146	100	5
B-202	141	130	126	12
B-203	144	143	120	10
B-204	145	144	117	9
BX-101	15	133	72	44
BX-102	28	137	33	59
BX-103	22	128	18	43
BX-104	41	75	50	68
BX-105	69	89	102	46
BX-106	57	98	95	42
BX-107	126	64	96	89
BX-108	64	115	133	36
BX-109	88	107	132	64
BX-110	111	53	108	94
BX-111	110	51	123	85
BX-112	118	90	92	54
BY-101	50	18	94	137

Table A-1. Tank Ranking by Data Category. (4 Sheets)

Tank	Rank by Ci/gal	Rank by Groundwater Risk	Rank by Airborne Risk	Rank by Estimated DST Space Used (least to greatest)
BY-102	105	37	89	109
BY-103	83	15	79	134
BY-104	45	20	75	124
BY-105	93	54	44	144
BY-106	66	8	105	132
BY-107	62	41	115	97
BY-108	77	50	110	88
BY-109	56	45	98	96
BY-110	68	29	90	120
BY-111	106	35	82	116
BY-112	100	33	86	118
C-101	20	114	41	84
C-102	35	111	4	90
C-103	5	83	3	99
C-104	32	61	2	110
C-105	18	59	7	86
C-106	8	119	66	26
C-107	9	66	5	102
C-108	53	108	136	72
C-109	14	78	101	76
C-110	130	79	104	77
C-111	7	112	65	49
C-112	12	63	51	79
C-201	81	135	107	15
C-202	63	136	119	16
C-203	119	125	128	20
C-204	115	127	146	17
S-101	30	44	32	129
S-102	78	36	70	100
S-103	61	30	64	95
S-104	38	68	34	122
S-105	117	5	38	135
S-106	85	16	97	136
S-107	42	73	8	104
S-108	80	10	22	141
S-109	120	12	88	115
S-110	59	23	37	127
S-111	43	27	112	111
S-112	104	26	29	148
SX-101	31	42	24	119

Table A-1. Tank Ranking by Data Category. (4 Sheets)

Tank	Rank by Ci/gal	Rank by Groundwater Risk	Rank by Airborne Risk	Rank by Estimated DST Space Used (least to greatest)
SX-102	47	22	49	130
SX-103	48	19	27	140
SX-104	37	40	12	133
SX-105	52	34	21	107
SX-106	76	7	45	113
SX-107	21	95	54	70
SX-108	6	106	10	63
SX-109	33	65	40	114
SX-110	29	99	80	52
SX-111	26	86	53	73
SX-112	23	100	61	58
SX-113	107	93	134	31
SX-114	34	72	60	87
SX-115	3	134	31	19
T-101	102	69	93	56
T-102	74	92	121	40
T-103	17	117	69	30
T-104	142	121	76	2
T-105	86	76	83	50
T-106	116	118	129	28
T-107	87	67	87	80
T-108	133	126	139	24
T-109	138	129	140	48
T-110	132	131	109	7
T-111	140	87	62	1
T-112	125	141	113	8
T-201	146	147	103	6
T-202	147	149	131	14
T-203	148	148	124	11
T-204	149	145	130	13
TX-101	25	85	35	65
TX-102	90	46	59	91
TX-103	92	56	71	81
TX-104	36	80	99	51
TX-105	95	3	17	145
TX-106	84	24	39	131
TX-107	60	81	52	38
TX-108	91	57	73	74
TX-109	123	70	77	103
TX-110	98	14	25	138

Table A-1. Tank Ranking by Data Category. (4 Sheets)

Tank	Rank by Ci/gal	Rank by Groundwater Risk	Rank by Airborne Risk	Rank by Estimated DST Space Used (least to greatest)
TX-111	99	28	36	126
TX-112	96	2	15	147
TX-113	131	1	85	149
TX-114	101	11	23	142
TX-115	94	4	19	143
TX-116	122	32	47	146
TX-117	112	38	43	139
TX-118	65	47	1	101
TY-101	134	109	91	69
TY-102	121	103	137	55
TY-103	97	77	84	66
TY-104	82	101	116	39
TY-105	73	71	125	78
TY-106	67	123	142	27
U-101	19	120	135	33
U-102	44	31	48	105
U-103	79	21	63	112
U-104	51	96	81	57
U-105	71	6	11	128
U-106	54	52	26	71
U-107	103	13	28	117
U-108	72	9	30	125
U-109	89	17	111	98
U-110	55	91	67	83
U-111	70	39	56	92
U-112	39	116	138	47
U-201	135	138	148	23
U-202	139	139	147	21
U-203	136	140	149	18
U-204	137	142	145	22