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Enclosure 1

DOCUMENT RELEASE AND CHANGE FORM

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By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
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This document is Revision 7 of the SST Retrieval Plan. The document was revised to incorporate best basis inventory estimates, data from C and AX Farm retrievals, and tank retrieval status as of July 2020.

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Single-Shell Tank Waste Retrieval Plan

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Abbreviations and Acronyms

ALC	air lift circulator
BBI	Best Basis Inventory
CH-TRU	contact handled transuranic
CD	chemical dissolution
DOE-ORP	Department of Energy – Office of River Protection
DSA	documented safety analysis
DST	double-shell tank
Ecology	Washington State Department of Ecology
ER	electrical resistivity
ERSS	extended reach sluicing system
ERSS-HPW	extended reach sluicing system-high pressure water
HFFACO	Hanford Federal Facility Agreement and Consent Order
HIHTL	hose-in-hose transfer line
HTRH	hard-to-remove heel
HTWOS/TOPSIM	Hanford Tank Waste Operations Simulator
ITV	in-tank vehicle
LOW	liquid observation well
MARS	mobile arm retrieval system
MARS-S	mobile arm retrieval sluicing system
MARS-V	mobile arm retrieval vacuum system
MRS	mobile retrieval system
MS-200	modified sluicing in 200 series tanks
MS-SD	modified sluicing saltcake dissolution
MS-SR	modified sluicing sludge removal
RCRA	Resource Conservation and Recovery Act
RDF	retrieval duration factor
SST	single-shell tank
TOC	tank operations contractor
TWINS	Tank Waste Information Network System

TWRWP	Tank Waste Retrieval Work Plan
VR-200	vacuum retrieval in 200 series tanks
WDF	waste difficulty factor
WRF	waste receipt facility
WTP	Waste Treatment and Immobilization Plant

1.0 PURPOSE

The purpose of this document is to provide the strategy for removal of the radioactive and chemical wastes stored in the Hanford underground single-shell tanks (SST). This plan is intended to provide a single, consistent basis for SST waste retrieval planning. The criteria and guidance in this plan provide a basis for the SST retrieval assumptions, waste volumes, and retrieval durations used in ORP-11242, *River Protection Project System Plan*.

2.0 KEY TASKS FOR SUCCESS

Section 9 of this plan provides bounding assumptions for the document. Should any of these assumptions be invalid there could be a significant negative impact on meeting the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology, et al.) Milestone M-45-70 date of 12/31/2040 to complete SST waste retrieval. Section 10 lists recommendations to maximize the potential for meeting Milestone M-45-70. Section 11 lists requirements to resolve SST retrieval planning problems and improve the planning process. Of these assumptions, recommendations, and requirements the following three items are the most critical to maximizing the potential for completing SST retrieval in the minimum amount of time.

1. **Decrease the total duration for retrieval operations** – Tanks undergoing retrieval operations through July 2020 had a gross retrieval duration factor (RDF) indicating retrieval was ongoing about 17% of the time, with twelve of the seventeen tanks having ongoing retrieval less than 10% of the time. The gross RDF is defined in RPP-40545, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, as the ratio of the retrieval operating time divided by what the operating time would have been if operations had occurred at 100% operating efficiency every shift between retrieval startup and when retrieval was halted. On days when retrieval operations were performed transfer times averaged 72% of the 100% efficiency rate. RPP-40545 estimates the RDFs for SST retrieval in the future will be in the 27 to 59% range depending upon the retrieval process assuming an ABCD shift schedule, with lower efficiencies for other shift schedules. The RPP-40545, Rev. 6 numbers, while an improvement over the efficiencies to date, are based mostly upon non-conservative assumptions and are low. A number of factors make up the RDF estimate, but those with the biggest impact are downtime for maintenance and repairs, delays related to safety basis and related concerns, and procedural requirements. Maintenance and repair delays cover both routine and non-routine maintenance, with the biggest maintenance impact being delays to respond to major equipment failures. Safety basis delays include those associated with continual reanalysis of conditions (approximately 36 potential inadequacies in the safety analysis have been evaluated between 2005 and November 2011) and from documentation/ fabrication requirements associated with safety significant equipment. Operating and administrative procedures are thorough but cumbersome and restrict the ability to respond quickly to changing conditions or problems.

2. **Reevaluation of assumed leaking tanks** – The retrieval process selected for a tank is based primarily upon the tank status of either "sound" or assumed "to have leaked in the past." As of July 13, 2020 there are 52 assumed leaking tanks listed in HNF-EP-0182, Rev. 390, *Waste Tank Summary Report for Month Ending June 30, 2020* that still need to be retrieved. It is possible that only a portion of these 52 tanks actually leaked, as many of the tanks were originally listed as questionable integrity or suspect leaking tanks due to unexplained (at the time) level drops without any definite confirmation of a tank leak. As of the end of June 2020, retrieval operations have been conducted in eight tanks previously or currently designated as assumed leaking tanks (C-201, C-202, C-203, C-204, C-101, C-105, C-110 and C-111), with no leakage evident in any of the eight tanks during or after retrieval operations. Table 10-1 lists 28 additional tanks which are recommended for a leak status reevaluation. If these tanks can be reclassified as sound or sound below a given waste level, the number of tanks using the vacuum retrieval with mobile vehicle assist, or mobile retrieval system (MRS), would be reduced. T-103, U-104, and U-112 have been reassessed and remain designated "assumed leakers." Though sound, T-106 is still planned to use MRS. The number of 200 series tanks using vacuum retrieval with no mobile assist (VR-200) would be reduced from four to zero. Elimination of VR-200 and most MRS tanks would eliminate these inefficient and complex processes as well as eliminate the potential radiological and safety basis problems associated with them. In addition, the number of tanks requiring the tank dome to be cut to install a new large central riser for the MARS-V system would be reduced from 10 to 3 (T-111 and U-110 have been reassessed and remain designated "assumed leakers." If categorized as sound, BX-102 would still require new large risers). Reducing the number of tank dome cuts for large riser installations from 10 to 3 (4 if the MRS is eliminated and T-106 is switched to MARS-V retrieval) would significantly reduce cost along with potential environmental and radiological problems.

3. **Revise MARS designs to ensure the MARS-V systems can fit within an existing 42-in. central riser** – The initial MARS design was intended to fit within a 42-in. riser. The mobile arm retrieval sluicing system (MARS-S) for C-107 and the MARS-V system for C-105 where both too large for a 42-in. riser due to structural concerns with the initial designs, prompting changes which slightly enlarged the maximum cross-sectional diameter. These MARS units where designed for 530 kgal tanks like those in B/BX/C/T/U farms. The MARS units for 758 kgal or 1,000 kgal tanks will have to be longer and thus may need more structural support than the current designs. It is assumed for this plan that improved MARS designs can be made that will fit into existing 42-in. SST risers, but this must be confirmed to give confidence in SST retrieval planning, especially for the 1,000 kgal A Farm tanks. Tables 6-1 and 6-2 show 38 MARS units are planned for deployment. 27 of which would be installed through existing 42-in. risers and 10 require new risers. If MARS systems can't be installed in these existing openings, the risers would have to be removed and larger ones installed, or alternate retrieval processes selected.

3.0 INTRODUCTION

This plan is a deliverable under the terms of U.S. Department of Energy contract DE-AC27-08RV14800 with Washington River Protection Solutions LLC. Section C.2.2.1 Sub-CLIN 2.1: Single-Shell Tank Retrieval of the contract states:

> *The Contractor shall develop, submit for DOE-ORP approval, implement, and maintain an Integrated SST Retrieval Plan (Deliverable C.2.2.1-1) that describes waste treatment, closure objectives, and near-term SST retrieval commitments.*

Waste treatment and closure objectives are not addressed in this SST retrieval plan. Waste treatment and closure are addressed sufficiently in the latest System Plan. Included within the scope of this plan are the following:

a. An overview of SST waste volumes and processes employed for SST waste retrieval.
b. The basis for waste retrieval process selection and the selected process for each SST.
c. The process to use for estimation of waste retrieval volumes and durations.
d. Guidelines for tank retrieval sequencing.
e. Assumptions that bound the planning in this document.
f. Recommendations for improvements to shorten the SST retrieval process.
g. Requirements to improve SST planning and/or resolve planning unknowns.

Revision 7 includes best basis inventory (BBI) data downloaded from TWINS 7/13/2020. Calculation formulas have been revised and retrieval parameters have been updated. Notable revision 7 changes include salt transition region and hard to remove heel (HTRH) volume estimates, non-process water volumes updates based on C Farm retrievals, RDF revisions, and waste difficulty factor (WDF) updates. Retrieval volumes and durations were revised based on the updated BBI values and retrieval methods were changed based on lessons learned and tank integrity classifications. This revision updates retrieval plans and assumptions, tank waste inventory data, and the status of retrieval operations through July 13, 2020.

Most retrieved SST wastes are transferred to Resource Conservation and Recovery Act (RCRA) compliant double-shell tanks (DST) for storage and blending in preparation for feed to the Waste Treatment and Immobilization Plant (WTP); some SST wastes (i.e., contact handled transuranic [CH-TRU]) are sent directly from an SST to a future on-site waste treatment facility.

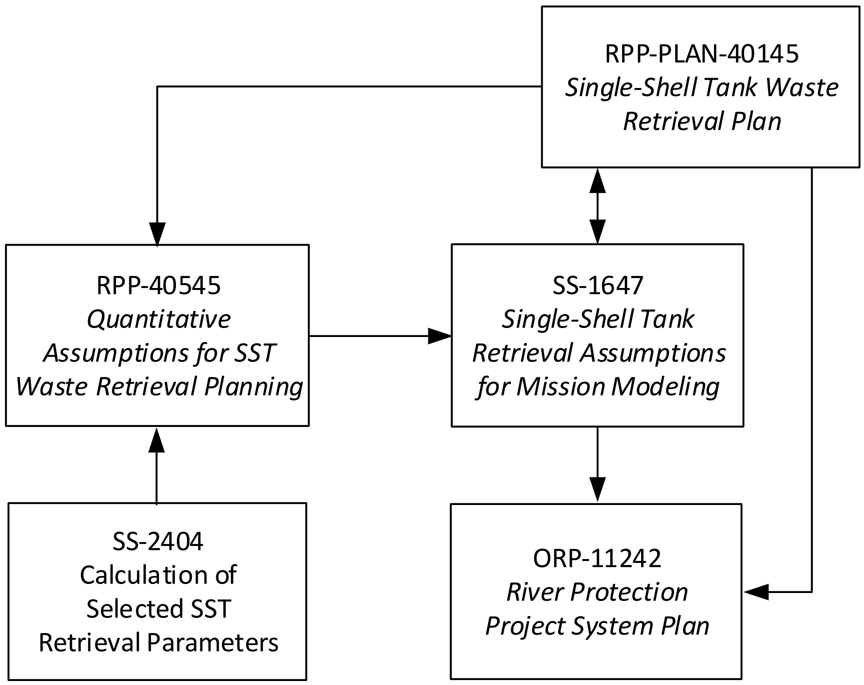
The retrieval of wastes from DSTs is outside the scope of this plan.

There are two documents and two spreadsheets used for SST retrieval planning. This document, RPP-PLAN-40145, is the technical guidance document for SST retrieval planning.
The information in this document is used as input to RPP-40545, and SS-1647, *Single-Shell Tank Retrieval Assumptions for Mission Modeling.*

RPP-40545 provides the technical assumptions, including the basis for those assumptions, used to estimate waste retrieval volumes and durations. Spreadsheet SS-1647 is used to calculate the waste retrieval volumes and durations. SS-1647 uses RPP-PLAN-40145 and RPP-40545 for

input to these calculations. SS-2404 is an input to RPP-40545. The output of RPP-PLAN-40145 and SS-1647 are input to ORP-11242.
Figure 1 shows the interrelationship of these documents.

Figure 1. Interrelationship of Single-Shell Tank Retrieval Documents.



4.0 SINGLE-SHELL TANK WASTE AND RETRIEVAL OVERVIEW

Appendix A provides a summary description of SST waste and tank information. As of July 13, 2020, waste retrieval for seventeen of the SSTs (all of C Farm and S-112) has been completed. Retrieval data reports for all of these tanks have been accepted by the Washington State Department of Ecology (Ecology). Retrieval operations have been conducted on two additional tanks (S-102, and AX-102) S-102 has been returned to storage mode and AX-102 is in preparation of retrieving the HRTH, if needed. The remaining 127 SSTs have not yet begun retrieval operations.

The Best Basis Inventory (BBI) provides accepted values for tank waste volumes and compositions. These values are used for all tank retrieval planning purposes to ensure consistency of results. The BBI volumes and compositions are based upon an evaluation of tank sample results data, tank fill and transfer history, and tank waste template composition values associated with processing operations at different Hanford facilities.

Appendix B discusses salt phosphate concentration, sludge phosphate, aluminum, and fluoride content, and the impact these constituents are expected to have on waste retrieval operations and waste volumes.

5.0 PROCESSES AND EQUIPMENT FOR SINGLE-SHELL TANK WASTE RETRIEVAL

The SST retrieval planning is based on data acquired through waste retrieval processes that have been used to date in Hanford tanks, as well as on processes that have been tested to the point where it is believed retrieval parameters for the method can be relied upon for calculation of retrieval volume and duration estimates. The processes that have been used or are planned for SST retrieval are:

- modified sluicing-sludge removal (MS-SR)
  - with an in-tank vehicle (ITV) for HTRH retrieval, or
  - with chemical dissolution (CD) for HTRH retrieval, or
  - in 200 series tanks with no HTRH retrieval required (MS-200)
- modified sluicing-saltcake dissolution (MS-SD)
  - with high pressure mixers or equivalent equipment for high phosphate salt, and
  - with an ITV for HTRH retrieval, or
  - with a continuation of the same process for HTRH retrieval
- extended reach sluicing system-high pressure water (ERSS-HPW)
  - sluicing with separate supernate and high pressure water nozzles attached to an arm with an extendable boom.
  - with CD for HTRH retrieval, or
  - with an ITV for HTRH retrieval
- MARS-S for
  - sludge removal
  - saltcake dissolution
- MARS-V for
  - sludge removal
  - saltcake dissolution
- MRS for
  - sludge removal
  - saltcake dissolution
- VR-200
  - 200-series tanks contain only sludge.

An overview of each of these processes is provided in Appendix C. A separate overview of the ERSS is not provided due to its similarity to modified slucing.

Appendix D provides an overview of the equipment needed to support the waste retrieval processes described in Appendix C. Conceptual designs have not been prepared for the transfer lines, diversion/valve boxes, waste receipt facilities (WRFs), and supporting infrastructure described in Appendix D. Since the equipment size and method of operation for the WRFs will have a direct bearing on the rate of SST waste retrieval it is necessary to make assumptions for WRF operation. Appendix D includes a section on WRF design and operation that is used for SST retrieval planning until the conceptual design is evolved.

6.0 WASTE RETRIEVAL PROCESS SELECTION

6.1 75-FOOT DIAMETER TANKS

Figure 2 provides the methodology to select a retrieval process for the 75-ft diameter tanks. Generally, the methodology is:

- If the tank is sound modified sluicing with ERSS is used.
- If the tank is sound and a specific need is identified, MARS-S is used, however; as of September 2016 no need for MARS-S is identified. A 42-in. riser will be added if necessary.
- If the tank is an assumed leaker and it has a central 42-in. riser, MARS-V is used.
- If the tank is an assumed leaker and it does not have a central 42-in. riser, MRS is used when the waste volume is small enough to be removed within a nominal year or less.
- If the tank is an assumed leaker, does not have a central 42-in. riser, and the volume is large enough that it may take more than a year to complete using MRS, a new large central riser is installed and MARS-V is used.

There are several exceptions to these criteria and additional considerations are explained in the following descriptions for each decision point in Figure 2.

Decision Point 1 – The primary criterion for retrieval process selection is whether the tank is categorized as sound or an assumed leaking tank. The official categorization for each SST is provided in HNF-EP-0182. Revision 390 of this document is used for RPP-PLAN-40145, Rev. 7. A tank designated as sound will use retrieval processes that are faster and less costly than those used for assumed leaking tanks, but which may result in more liquid being present in the tank at a given time.

Decision Point 2 – This decision point addresses the situation when the tank is considered sound but Ecology states the waste in the tank cannot be retrieved using processes normally applied to sound tanks. For a time, tank C-105 was in this situation; however, RPP-ASMT-46452, 2010, *Tank 241-C-105 Leak Assessment Completion Report*, Rev. 0, concluded that a leak from the tank cannot be ruled out and the tank integrity designation was changed to "assumed leaker."

Decision Point 3 – This is the main decision point for whether to use modified sluicing with ERSS or MARS-S for retrieval. The ERSS has evolved and provides most of the important features a MARS-S provides.

There may also be selected tanks in the future where technical reasons result in MARS-S being preferred over ERSS. If equipment costs are not considered, the MARS-S is a viable technology which may also have the advantage of retrieving waste to below the HFFACO 360 ft^3 limit with no additional heel removal technology required. Difficulties occurred with MARS-S retrieval in C-107. The sluicing supernate used was saturated with phosphate and when it was sprayed into C-107 the supernate cooled and phosphate precipitated. The phosphate precipitation has made it difficult to determine the actual effectiveness of the MARS-S system. The MARS-S has also retrieved waste somewhat faster than modified sluicing. When equipment costs are included MARS-S is at a disadvantage since the MARS-S equipment cost may be two to three times that for standard modified sluicing or ERSS with an ITV. Currently there is no basis developed to support the selection of MARS-S over modified sluicing/ERSS with an ITV.

Decision Point 4 – Even though a tank does not have the central 42-in. riser necessary for MARS-S installation, there may still be a specific reason to use MARS-S to install a riser so it can be used in the tank. A central 55-in. riser was added to tank C-107 to provide operating experience for the MARS-S and see how it will perform for heel removal in a tank.
The MARS-S performed satisfactorily during cold testing in FY-2009 and retrieved satisfactorily in C-107.

Decision Point 5 –Decision Point 5 makes the choice for the method of heel removal for tanks with ERSS modified sluicing deployed. This will be a technical decision dependent upon conditions in the tank at the time the heel volume is apparent. For planning purposes it is assumed that chemical dissolution is the preferred method because it has been the most successful method for heel reduction and will take less time than particle size reduction with an ITV. Chemical dissolution could have a negative impact on WTP operation due to extra oxalate and/or extra sodium in the waste. While sluicing C-112 with an extended reach sluicer it was discovered that there was a sludge layer under the hard crust. This crust layer was also believed to be present in C-111. At this time, the 22 air lift circulators (ALCs) in each AX tank are assumed to prevent use of an umbilical cord-operated ITV, so CD is assumed for the AX tank sludge heels.

Chemical dissolution was used for C-104, C-108, C-109, C-111 and C-112 HTRH retrievals. C-110 used an ITV which lost mobility towards the end of retrieval and ended up assisting with incidental phosphate dissolution during heel rinsing.

It is assumed that the AX Farm tanks containing saltcake will have their saltcake heels removed with continued low efficiency water sluicing. Since CD is only effective for sludge removal, it would be of little benefit for removing a saltcake heel. Thus, it is assumed that for saltcake

HTRH retrieval in the AX tanks, the time will be taken to continually recycle solution over the salt until it is dissolved, with CD for the residual sludge.

Decision Point 6 – There are currently 52 unretrieved tanks listed as assumed leaking tanks in HNF-EP-0182. Many of the 52 tanks may not have a liner leak; they were put on the "assumed leaker" list at a time when designation as an assumed leaker had little impact on tank farm operations. Prior to retrieval of the four C-200 assumed leaking tanks, documentation was presented to Ecology that indicated these tanks did not leak, but the information was not accepted. The post-retrieval mass balance calculations required for leak evaluation by RPP-16525, *C-200 Series Tanks Functions and Requirements*, showed no indication that any of the four tanks leaked during the retrieval process. These calculations are provided in retrieval data reports RPP-RPT-30181, *Retrieval Data Report for Single-Shell Tank 241-C-201*; RPP-RPT-29095, *Retrieval Data Report for Single-Shell Tank 241-C-202*; RPP-RPT-26475, *Retrieval Data Report for Single-Shell Tank 241-C-203*; and RPP-RPT-34062, *Retrieval Data Report for Single-Shell Tank 241-C-204*.

In order to obtain agreement with Ecology on estimated tank leak volumes and inventories, the process described in RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning,* was implemented in 2007. This process involves an evaluation of tanks in a farm by a group including the tank operations contractor (TOC), U.S. Department of Energy, Office of River Protection (DOE-ORP), and Ecology and recommendations whether or not to reassess the integrity designation for a tank. While this process does not alter the integrity status of a tank, the results have been used (C-110, C-111 and C-101) to justify modified sluicing for retrieving the waste from a tank prior to completion of an integrity assessment.

Eleven tanks (A-103, AX-102, AX-104, C-101, C-110, C-111, S-104, SX-104, SX-110, T-101 and T-109) previously listed in HNF-EP-0182 as assumed leakers were evaluated in the RPP-32681 process and consensus was reached that these tanks likely either did not leak from the tank liner or that any leakage was above the current waste level in the tank.

The RPP-32681 review for C-101 is documented in RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105 and Unplanned Waste Releases*. Ecology tentatively agreed this tank could be retrieved with modified sluicing providing that the C-101 liquid level was maintained less than 54 in. during retrieval, that two slant bore holes were drilled near C-101, and that the borehole results provided to Ecology indicated the tank likely didn't leak below 54 in. The boreholes were complete in 2011 and the logging results showed no evidence the tank leaked. As a result, Tank C-101 was retrieved using modified sluicing with an ERSS and high pressure water. Tank C-101 had retrieval completed down to the HTRH in September 2013 with no evidence of a tank leak.

The RPP-32681 review for C-110 and C-111 is also documented in RPP-ENV-33418. Tank C-110 had retrieval completed down to the HTRH in 2008-2009 with no evidence of a tank leak. Tank C-111 had retrieval completed in 2016 with no evidence of a tank leak.

The RPP-32681 review for A-103, AX-102, and AX-104 is documented in RPP-ENV-37956, *Hanford A and AX-Farm Leak Assessments Report: 241-A-103, 241-A-104, 241-A-105, 241-AX-102, 241-AX-104 and Unplanned Waste Releases*.

The RPP-32681 review for S-104 is documented in RPP-RPT-48589, *Hanford 241-S Leak Assessment Report.*

The RPP-32681 review for SX-104 and SX-110 is documented in RPP-ENV-39658, *Hanford SX-Farm Leak Assessments Report.*

The formal leak status of a tank is not changed without a formal integrity assessment conducted per the requirements of TFC-ENG-CHEM-D-42, *Tank Leak Assessment Process* (pre 2020) or TFC-ENG-CHEM-P-57, *Intrusion Notification and Leak Assessment Process.* The following integrity assessments were conducted resulting in the leak status being changed to sound in HNF-EP-0182:

- The TFC-ENG-CHEM-D-42 leak assessment report for C-110 is documented in RPP-ASMT-38219, Rev. 0, *Tank 241-C-110 Tank Leak Assessment Report*.
- The TFC-ENG-CHEM-D-42 leak assessment report for C-111 is documented in RPP-ASMT-39155, Rev. 0, *Tank 241-C-111 Tank Leak Assessment Report*.
- The TFC-ENG-CHEM-D-42 leak assessment report for A-103 is documented in RPP-ASMT-42278, Rev. 0, *Tank 241-A-103 Tank Leak Assessment Report*.
- The TFC-ENG-CHEM-D-42 leak assessment report for AX-102 is documented in RPP-ASMT-42628, Rev. 0, *Tank 241-AX-102 Tank Leak Assessment Report.*
- The TFC-ENG-CHEM-D-42 leak assessment report for AX-104 is documented in RPP-ASMT-42628, Rev. 0, *Tank 241-AX-104 Tank Leak Assessment Report.*
- The TFC-ENG-CHEM-D-42 leak assessment report for SX-104 is documented in RPP-ASMT-38450, Rev. 0, *Tank 241-SX-104 Tank Leak Assessment Report* and RPP-ASMT-48143, Rev. 0, *Tank 241-SX-104 Tank Leak Assessment Completion Report*.
- The TFC-ENG-CHEM-D-42 leak assessment report for SX-110 is documented in RPP-ASMT-47140, Rev. 0, *Tank 241-SX-110 Tank Leak Assessment Report*.
- The TFC-ENG-CHEM-D-42 leak assessment report for S-104 is documented in RPP-ASMT-62316, Rev. 0, *Leak Assessment Report for Tank 241-S-104.*
- The TFC-ENG-CHEM-D-42 leak assessment report for T-101 is documented in RPP-ASMT-62935, Rev. 0, *Leak Assessment Report for Tank 241-T-101.*
- The TFC-ENG-CHEM-P-57 leak assessment report for T-109 is documented in RPP-ASMT-63776, Rev. 0, *Leak Assessment Report for Tank 241-T-109.*
- The TFC-ENG-CHEM-D-42 leak assessment report for T-103 is documented in RPP-ASMT-63257, Rev.0, *Leak Assessment Report for Tank 241-T-103.*

- The TFC-ENG-CHEM-D-42 leak assessment report for C-105 is documented in RPP-ASMT-46452, *Tank 241-C-105 Leak Assessment Completion Report.*

Tanks A-103, AX-102, AX-104, C-101, C-110, C-111, SX-104, and SX-110 are shown as using modified sluicing with ERSS in Table 6-1.

Recommendation 10.4 is that the tanks categorized as assumed leakers go through the RPP-32681 review (and if needed, the TFC-ENG-CHEM-P-57 leak assessment process) to see which could be retrieved as sound tanks, which has been completed for all SSTs in all farms. Tank integrity assessments [TFC-ENG-CHEM-P-57] are recommended as shown in Table 10-1.

Decision Point 7 – Whether the tank has a central 42 in. riser or not is a decision point for MARS-V vs. MRS. The MARS-V is preferable to the MRS as it is expected to be faster, more effective, less complicated, and have less liquid present in the tank during retrieval. See Assumption 9.15 on minimum MARS-V riser diameter.

Decision Point 8 – There may be tanks with 42 in. central risers in which MARS-V can't be used because the central riser contains equipment that can't be removed, or removed with extreme difficulty, or there is another reason for not using MARS-V. The tanks in this category are BY-103, TX-105, TX-110, TX-114, and TX-117. BY-103, TX-105, TX-110, and TX-114 have ALCs installed that are embedded in salt. It would take a lot of water and effort to remove these ALCs, and the volume of water would be undesirable in light of the assumed leaker status of the tanks. TX-117 was reported to have a radial crack in the tank dome in 1969. Because of the large weight of the MARS-V equipment the MARS-V would not be used on the tank unless the dome integrity was analyzed and shown to be able to support the load, or a special support platform was built over the tank to distribute the equipment weight to an acceptable level.

Tanks BY-103, TX-105, TX-110, TX-114, and TX-117 thus all become Special Case tanks. It is assumed that MRS would not be used for these tanks, these tanks each contain 413 to 576 kgal of waste, far more than the 62 kgal (see Decision Point 11) assumed to be the maximum for an MRS tank. Effective means of waste retrieval need to be developed for these tanks. Section 6.1.1 provides the retrieval processes for these tanks assumed for SST retrieval planning.

Decision Point 9 – If the assumed leaking tank does not have a central 42-in. riser, it will have to have a riser elsewhere capable of permitting the MRS- ITV access to the tank. The ITV requires a minimum 27-in. diameter hole to access a tank. The tanks that do not have a 42-in. central riser are those in AX, B, BX, T, and U Farms, plus BY-110. The AX tanks have risers that could be used for MRS ITV insertion but are precluded from using the MRS due to the presence of the 22 ALCs. The remaining five tank farms all have elliptically shaped manholes with a minimum cross-section of about 31 in. Most of these manholes are sealed underground at the top of the tank dome, while some have had access risers added over the years. Tank BY-110 is categorized as sound and as such is not evaluated for Decision Point 9. There are no known tanks in B, BX, T, or U Farms that could not provide access to the MRS -ITV, assuming the addition of a manhole access riser extension.

Decision Point 10 – There is currently only one tank designated as an assumed leaker with no 42-in. central riser that is unacceptable for use with the MRS. This is B-105. The BBI shows this tank to be approximately half full with saltcake. In-tank photos of the tank show it to be significantly crusted over with a thick salt layer near the top of the tank, with a large open volume underneath. The MRS would not be effective in this tank. Tank C-105 also received a Yes response to Decision Point 10 as it was selected as the demonstration tank for the first MARS-V system.

Decision Point 11 – The HFFACO had, until recently, a requirement to complete retrieval on a tank within 12 months from initiation of retrieval. Many of the SST retrievals have taken longer than 12 months, but none were begun with the intent that the duration would be that long. The maximum waste volume that can be retrieved with an MRS in an SST within a 12-month period is estimated to be approximately 64 kgal in RPP-40545, Rev. 5. No tanks with more than 62 kgal are assumed to use MRS. While the 12-month requirement for a tank retrieval duration has been removed from the HFFACO, the 62-kgal criterion is maintained for SST retrieval planning as a reasonable basis for selection of MRS or MARS-V for Decision Point 11, plus there is no certainty that a 12-month requirement won't be reinstated in the future. Those tanks with a Yes response to Decision Point 11 are B-103, B-112, BX-101, BX-108, T-103, T-106, T-108, T-109, U-101, U-104 and U-112.

It is assumed for MRS tanks no additional equipment is needed to mobilize high phosphate salt for retrieval; the high pressure water on the ITV is assumed adequate for saltcake mobilization. The number of MRS tanks that will be installed on tanks with high phosphate salt is noted separately from other MRS units because the retrieval process will likely be less efficient for these tanks.

Decision Point 12 – All tanks remaining at this point are assumed to require the addition of a 42-in. central riser so the MARS-V can be used, unless there is something preventing use of the MARS-V. The only tank at this time known to have a Yes response to Decision Point 12 is B-105. Although a MARS-V could be installed in the tank, it would not likely be any better at minimizing liquids present than an ERSS in removing the upper crust layer and salt on the sidewalls because most of the dissolved salt solution will run to the center of the tank before it can be withdrawn by the MARS-V suction. B-105 is thus another Special Case tank. Section 6.1.1 provides the retrieval process for B-105 assumed for SST retrieval planning.

Decision Point 13 – Only one tank has a Yes response to Decision Point 13. Tank A-105 is assumed to use a MARS-V for retrieval, assuming the No response to Decision Point 8 is correct and the MARS-V will fit above the liner (see Assumption 9.18). The basic MARS-V process as described in Appendix C won't be too effective in the tank due to the bulged bottom (see Appendix E), as much of the liquid sprayed on the sludge to mobilize it will run downhill and either collect in one spot or drain over the edge of the ripped liner to the concrete underneath. A-105 thus becomes another Special Case tank. Section 6.1.1 provides the retrieval process for A-105 assumed for SST retrieval planning.

It is assumed for MARS-V tanks that no additional equipment is needed to mobilize high phosphate salt for retrieval. The number of MARS-V systems that will be installed on tanks with high phosphate salt is noted separately from other MARS-V units because the retrieval process will likely be less efficient for these tanks.

6.1.1 Special Case Tanks

There are 7 tanks categorized as special case tanks after following the Figure 2 selection process.

Tanks BY-103, TX-105, TX-110, TX-114 and TX-117 all had a Yes response to Decision Point 8. It is assumed that a method can be developed to remove the ALCs from the first four tanks or cut them off so a MARS-V unit can be installed to work around them. It is also assumed that a suitable means of MARS-V equipment support can be devised for TX-117. Therefore, for the purpose of SST retrieval planning these 5 tanks will be assumed to use MARS-V for retrieval. These tanks are not currently listed in Recommendation 10.4 to have their leak status re-evaluated as it appears each of them have shown some evidence of increased radiation levels in nearby drywells. If the tanks could be re-evaluated as sound below a given level the tanks could be retrieved with an ERSS. See Assumptions 9.16 and 9.17, and corresponding Requirements 11.1 and 11.2.

Tank B-105 had a Yes response to Decision Point 12. For SST retrieval planning purposes only, B-105 is assumed retrieved using an ERSS with CD for the HTRH despite its current designation as an assumed leaker. Based upon the waste form in this tank ERSS under controlled conditions could be more effective than a MARS-V system with the same or less free liquid in the tank. In addition B-105 is one of the tanks recommended for reevaluation as a sound tank in Recommendation 10.4. The basis for this tank being an assumed leaker was an unexplained level drop only; no drywell increases were noted. An unexplained level drop is understandable when looking at photos of the waste surface in the tank.

A-105 had a Yes response to Decision Point 13. It is possible that risk calculations will indicate it is best to let the waste in this tank under the liner remain. For SST retrieval planning it will conservatively be assumed that the waste under the liner will be retrieved with a chemical dissolution. Waste above the liner will be retrieved using a MARS-V system, but the equipment will be modified and augmented to improve waste retrieval. For the purpose of SST retrieval planning only, A-105 retrieval is assumed to consist of:

- Installation of a MARS-V system through the central 42 in. riser (with the downcomer removed, see Assumptions 9.13 and 9.18).
- The MARS-V head will be modified with a moderately flexible extension on the suction nozzle so the end of the extension can be inserted into the opening between the torn tank liner and the main body of the tank.
- One or more sluicers will be installed in the tank.
- The sluicers will be used to mobilize the sludge in a similar fashion to modified sluicing with an ERSS. The MARS-V head high pressure water and supernate sluicers may also be used.
- The slurry will run downhill and drain into the breach, or collect in a low spot above the liner.
- The MARS-V head will position the suction nozzle extension at a suitable low spot to remove the slurry.

When the visible sludge in the tank is removed to the extent practical the sludge under the liner will be removed as practical using chemical dissolution. The heel solution would be removed via the MARS-V suction nozzle extension. There appears to be one penetration through the liner below riser 9 that was etched with acid to add a thermocouple. This penetration could possibly be used to remove waste slurry with the MARS-V suction extension.

Table 6-1 lists the decision point responses and the retrieval processes selected for each 75-ft diameter tank resulting from the selection process in Figure 2. Table 6-2 summarizes the tanks for each retrieval process.

Appendix E discusses tanks identified to date that may present special problems or concerns for retrieval process selection.

Appendix F provides a list of selected physical information sources available on SST contents that are used for SST retrieval planning. Much of the information used to estimate retrieval parameters in RPP-40545 is based upon tank sampling, interpretation of tank liquid observation well (LOW) data, and saltwell pumping historical data. The BBI composition for tanks without sample data are based primarily upon templates and what is known of the tank fill history. Appendix F is used to note which tanks should have sufficient information for confident retrieval planning and where planning could benefit from additional tank sampling.

6.2 20-FOOT DIAMETER TANKS

The retrieval process selection for 200 series tanks is straightforward.

B-200 Tanks. Three of these tanks are assumed leakers (B-201, B-203, and B-204). These tanks are listed in Recommendation 10.4 to have their leak status be reevaluated. Until that time, these tanks are assumed to be retrieved with a VR-200 process similar to that used for the C-200 tanks, but with changes made for more effective operation. The fourth tank (B-202) is designated as sound and does not require vacuum retrieval, but vacuum retrieval is assumed for this tank for efficiency. Vacuum retrieval is slower and the equipment is more expensive and elaborate than that for modified sluicing. However, with three of the tanks using vacuum retrieval the added equipment cost for vacuum retrieval of B-202 will be less than the additional equipment cost for modified sluicing equipment since most of the B-202 retrieval equipment would be common equipment shared with the other three B-200 tanks. Adding modified sluicing equipment to the same area around the B-200 tanks as the VR-200 equipment will significantly crowd the area, complicate the control room layout, and potentially double the number of procedures required.

C-200 Tanks. Retrieval has been completed for these tanks using vacuum retrieval.

T-200 Tanks. All four of these tanks are classified as sound. Modified sluicing is assumed as it will be faster than vacuum retrieval, will incur lower cost, have less equipment, and pose fewer radiological, technical, maintenance, and nuclear safety concerns.

U-200 Tanks. All four of these tanks are classified as sound. Modified sluicing is assumed as it will be faster than vacuum retrieval, will incur lower cost, have less equipment, and pose fewer radiological, technical, maintenance, and nuclear safety concerns.

Tables 6-1 and 6-2 list the retrieval processes selected for each 20 ft diameter tank based upon the information in the paragraphs above.

Figure 2. Waste Retrieval Selection Process for 75-Foot Diameter Tanks.

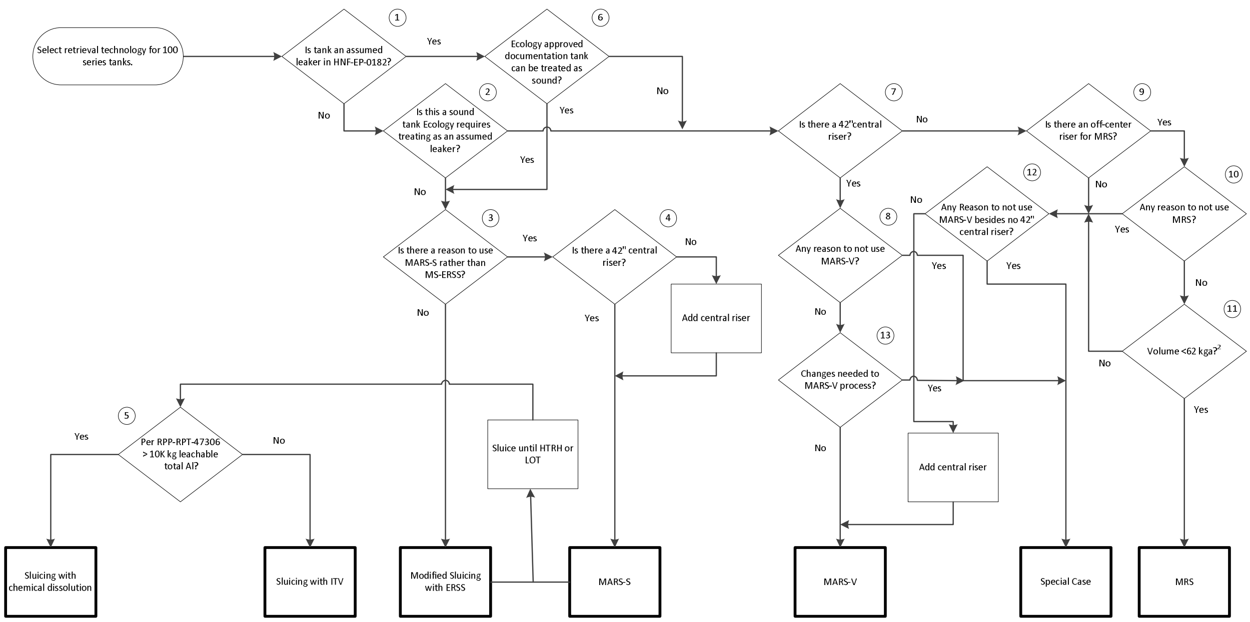


Table 6-1. Selected Retrieval Processes (4 Sheets)

Tank	Decision Point Number													New Large Central Riser?	Three New Small Risers?	Retrieval Process
	1	2	3	4	5	6	7	8	9	10	11	12	13			
A-101	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
A-102	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
A-103	Y	-	N	-	CD	Y	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
A-104	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
A-105	Y	-	-	-	CD	N	Y	N	-	-	-	-	Y	-	-	Mod MARS-V+CD
A-106	N	N	Y	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
AX-101	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
AX-102	Y	-	N	-	CD	Y	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
AX-103	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
AX-104	Y	-	N	-	CD	Y	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
B-101	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
B-102	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-ITV[1]
B-103	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS[1]
B-104	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-ITV[1]
B-105	Y	-	-	-	CD	N	N	-	Y	Y	-	Y	-	-	X	ERSS-HPW-CD[1]
B-106	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
B-107	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V[1]
B-108	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-CD[1]
B-109	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-CD[1]
B-110	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
B-111	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
B-112	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS[1]
B-201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VR-200
B-202	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VR-200
B-203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VR-200
B-204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VR-200
BX-101	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
BX-102	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
BX-103	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
BX-104	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
BX-105	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-ITV[1]
BX-106	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-ITV[1]
BX-107	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
BX-108	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
BX-109	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
BX-110	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V[1]
BX-111	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V[1]
BX-112	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
BY-101	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]

Table 6-1. Selected Retrieval Processes (4 Sheets)

Tank	Decision Point Number													New Large Central Riser?	Three New Small Risers?	Retrieval Process
	1	2	3	4	5	6	7	8	9	10	11	12	13			
BY-102	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
BY-103	Y	-	-	-	-	N	Y	Y[3]	-	-	-	-	-	-	-	SpC (MARS-V)[2,1]
BY-104	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
BY-105	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
BY-106	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
BY-107	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
BY-108	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V[1]
BY-109	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
BY-110	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[3]
BY-111	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
BY-112	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
C-101	Retrieval Completed															ERSS-HPW
C-102	Retrieval Completed															ERSS-HPW
C-103	Retrieval Completed															MS
C-104	Retrieval Completed															MS+CD
C-105	Retrieval Completed															ERSS-HPW
C-106	Retrieval Completed															MS+CD
C-107	Retrieval Completed															MARS-S
C-108	Retrieval Completed															MS+CD
C-109	Retrieval Completed															MS+CD
C-110	Retrieval Completed															MS+ITV
C-111	Retrieval Completed															MS+CD
C-112	Retrieval Completed															MS+CD
C-201	Retrieval Completed															VR-200
C-202	Retrieval Completed															VR-200
C-203	Retrieval Completed															VR-200
C-204	Retrieval Completed															VR-200
S-101	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
S-102	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
S-103	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
S-104	N	N	N	-	ITV	-	-	-	-	-	-	-	N	-	-	ERSS-HPW-ITV
S-105	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
S-106	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
S-107	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
S-108	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
S-109	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
S-110	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
S-111	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
S-112	Retrieval Completed															MS+ITV

Table 6-1. Selected Retrieval Processes (4 Sheets)

Tank	Decision Point Number													New Large Central Riser?	Three New Small Risers?	Retrieval Process
	1	2	3	4	5	6	7	8	9	10	11	12	13			
SX-101	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
SX-102	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
SX-103	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
SX-104	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
SX-105	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
SX-106	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
SX-107	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-108	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-109	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-110	N	N	N	-	ITV	Y	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
SX-111	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-112	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-113	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-114	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
SX-115	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
T-101	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
T-102	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
T-103	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
T-104	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
T-105	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
T-106	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
T-107	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
T-108	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS[1]
T-109	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
T-110	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
T-111	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
T-112	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
T-201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
T-202	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
T-203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
T-204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
TX-101	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
TX-102	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
TX-103	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
TX-104	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
TX-105	Y	-	-	-	-	N	Y	Y	-	-	-	-	-	-	-	SpC (MARS-V)[2]
TX-106	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
TX-107	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
TX-108	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD

Table 6-1. Selected Retrieval Processes (4 Sheets)

Tank	Decision Point Number													New Large Central Riser?	Three New Small Risers?	Retrieval Process
	1	2	3	4	5	6	7	8	9	10	11	12	13			
TX-109	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
TX-110	Y	-	-	-	-	N	Y	Y	-	-	-	-	-	-	-	SpC (MARS-V)[2]
TX-111	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
TX-112	N	N	N	-	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD[1]
TX-113	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V[2,1]
TX-114	Y	-	-	-	-	N	Y	Y	-	-	-	-	-	-	-	SpC (MARS-V)[2,1]
TX-115	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
TX-116	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
TX-117	Y	-	-	-	-	N	Y	Y	-	-	-	-	-	-	-	SpC (MARS-V)[2,1]
TX-118	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
TY-101	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V[2,1]
TY-102	N	N	N	-	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV[1]
TY-103	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V[2,1]
TY-104	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
TY-105	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
TY-106	Y	-	-	-	-	N	Y	N	-	-	-	-	N	-	-	MARS-V
U-101	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
U-102	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
U-103	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-CD[1]
U-104	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
U-105	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
U-106	N	N	N	N	ITV	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-ITV
U-107	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-CD[1]
U-108	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
U-109	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	X	ERSS-HPW-CD[1]
U-110	Y	-	-	-	-	N	N	-	Y	N	N	N	-	X	-	MARS-V
U-111	N	N	N	N	CD	-	-	-	-	-	-	-	-	-	-	ERSS-HPW-CD
U-112	Y	-	-	-	-	N	N	-	Y	N	Y	-	-	-	-	MRS
U-201	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
U-202	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
U-203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200
U-204	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MS-200

[1] Salt is greater than 2.0 anion mole % PO4.

[2] BY-103, TX-105, TX-110, and TX-114 have ALCs in central 42 in. risers, TX-117 has reported radial dome crack that will prevent MARS-V use until evaluated for dome loading.

[3] BY-110 has no central 42 in. riser.

Table 6-2. Summary of Tanks and Retrieval Processes (2 Sheets)

ERSS/ Modified Sluicing/HPW + CD		ERSS/Modified Sluicing/HPW +ITV	MARS-V	MRS	MS-200	VR-200
241-A-101	241-S-106	241-B-102	241-A-104	241-B-103	241-T-201	241-B-201
241-A-102	241-S-108	241-B-104	241-A-105+CD	241-B-112	241-T-202	241-B-202
241-A-103	241-S-110	241-B-106	241-B-101	241-BX-101	241-T-203	241-B-203
241-A-106	241-S-111	241-BX-105	241-B-107	241-BX-108	241-T-204	241-B-204
241-AX-101	241-SX-101	241-BX-106	241-B-110	241-T-103	241-U-201	
241-AX-102	241-SX-102	241-BX-109	241-B-111	241-T-106	241-U-202	
241-AX-103	241-SX-103	241-BX-112	241-BX-102	241-T-108	241-U-203	
241-AX-104	241-SX-104	241-BY-111	241-BX-110	241-U-101	241-U-204	
241-B-105	241-SX-105	241-S-102	241-BX-111	241-U-104		
241-B-108	241-SX-106	241-S-104	241-BY-103	241-U-112		
241-B-109	241-T-102	241-S-105	241-BY-105			
241-BX-103	241-T-104	241-S-107	241-BY-106			
241-BX-104	241-TX-102	241-S-109	241-BY-107			
241-BX-107	241-TX-103	241-SX-110	241-BY-108			
241-BY-101	241-TX-106	241-T-101	241-SX-107			
241-BY-102	241-TX-108	241-T-105	241-SX-108			
241-BY-104	241-TX-109	241-T-109	241-SX-109			
241-BY-109	241-TX-111	241-T-110	241-SX-111			
241-BY-110	241-TX-112	241-T-112	241-SX-112			
241-BY-112	241-U-102	241-TX-101	241-SX-113			
241-S-101	241-U-103	241-TX-104	241-SX-114			
241-S-103	241-U-105	241-TX-118	241-SX-115			
241-U-107	241-U-109	241-TY-102	241-T-107			
241-U-108	241-U-111		241-T-111			
			241-TX-105			
			241-TX-107			
			241-TX-110			
			241-TX-113			
			241-TX-114			
			241-TX-115			
			241-TX-116			
			241-TX-117			
			241-TY-101			
			241-TY-103			
			241-TY-104			
			241-TY-105			

Table 6-2. Summary of Tanks and Retrieval Processes (2 Sheets)

ERSS/ Modified Sluicing/HPW + CD		ERSS/Modified Sluicing/HPW +ITV	MARS-V	MRS	MS-200	VR-200
			241-TY-106			
			241-U-110			

7.0 ESTIMATION OF WASTE RETRIEVAL VOLUMES AND DURATIONS

The information needed for waste retrieval planning includes the volume of waste added to the DST system (or CH-TRU facility) during retrieval and the duration of each retrieval operation. The volume of waste generated is a function of the retrieval process selected, the motive fluid used for retrieval, the waste slurry concentration in the transfer line from the SST and miscellaneous additional water added to the tank. The waste slurry concentration in the transfer line is dependent upon tank and waste conditions. The duration of a retrieval operation is dependent upon volume of waste slurry generated, the waste slurry flow rate, time of pump operation per shift, the shift schedule, and the RDF for the process.

All the parameters used to estimate waste volumes and durations are provided in RPP-40545. RPP-40545 derives a value for each waste retrieval parameter and provides a justification as to why it was selected. The document also provides a description of how waste retrieval volumes and durations are calculated.

The RPP-40545 parameters are input to the retrieval volumes and duration calculation spreadsheet SS-1647.

The assumed base shift schedule for all tank retrieval operations is ABCD shift. To effectively provide feed to the DST system for transfer to the WTP, SST waste retrieval operations must provide feed at a rate similar to or greater than the WTP processing rate. This will require an ABCD shift operation using the retrieval parameters in RPP-40545.

Other shift schedules could be used for planning purposes only if there is no significant impact on WTP operating duration.

8.0 GUIDELINES FOR USE IN SYSTEM PLAN ANALYSES

This section provides guidelines for retrieval planning used in preparation of logic for the Hanford Tank Waste Operations Simulator (HTWOS/TOPSIM) program employed for ORP-11242 System Plan analyses. Guidelines are decisions which impact calculations that estimate the timing for when a tank is retrieved. None of these guidelines are mandatory. These are recommended guidelines which, if followed to the extent practical, should result in the most effective SST waste retrieval program. Deleted guidelines have been resolved or are no longer applicable.

8.1 Retrieval operations should concentrate within one tank farm or group of adjacent farms at a time in 200 East Area and one tank farm or group of adjacent farms at a time in 200 West Area. Retrieval within more than one tank farm or group of adjacent farms in an area may be included in the planning process if practical within assumed resource availability and if there is a definite schedule benefit to doing so.

Basis: Prior to System Plan 5, baseline planning for SST waste retrieval assumed waste would be retrieved from the tank deemed optimum at the time for feed to the WTP. This assumption is impractical to meet without almost unlimited resources, significant additional DST storage, and blending capability. To enable waste to be retrieved from any SST or any SST farm on demand would require significant retrieval infrastructure to be installed in the near term and require all the systems to be maintained in all the farms until ready for use. Concentrating retrieval operations in a single farm or group of adjacent farms will enable a concentrated utilization of resources and result in being able to proceed to closure on a tank farm at an earlier time than if simultaneous retrievals were conducted from all tank farms.

8.2 Refer to the most recent Consent Decree or TPA retrieval milestones for planned retrievals and schedules.

Basis: The Amended Consent Decree Case No. CV-08-CV-5085-FVS[1] does not include specific retrieval commitments beyond A and AX Farm.

8.3 Deleted.

Basis: AX Farm is in process of being retrieved to AZ-102 and A Farm design is sufficiently matured to prevent change from receipt tank AP-101.

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[1] The "Consent Decree" collectively refers to the Consent Decree in Case No. 2:08-cv-05085-FVS (October 25, 2010), the Amended Consent Decree, Case No. 2:08-cv-05085-RMP (March 11, 2016), and the Second Amended Consent Decree, Case No. 2:08-cv-05085-RMP (April 12, 2016) and the Third Amended Consent Decree, Case No. 2.08-cv-05085-RMP (October 12, 2018). The TWRWP requirements of the October 25, 2010 Consent Decree were not modified by either the Amended Consent Decree or the Second Amended Consent Decree.

8.4 In West Area S/SX tanks should be retrieved first, followed by those in the T/TX/TY grouping, then U Farm.

Basis: It is not a significant advantage to begin in S/SX rather than in T/TX/TY or U Farm, except that there are no transfer lines or associated equipment from T/TX/TY and U Farms up to SY farm. There is little benefit in proceeding in all farms at the same time even if transfer equipment and funding were available, since there are only three West Area DSTs available for waste receipt. Effective retrieval operations in 200 West Area require preparation of at least two and preferably all three of the SY DSTs for receipt of SST waste.

The main reason to begin in S/SX is because retrieval has already begun in S Farm. More infrastructure exists, plus new hose-in-hose transfer lines (HIHTLs) can be used for transfer of solutions from S/SX to the SY Farm DSTs. A longer lead time than needed for S/SX retrieval preparation will be required to install stainless steel transfer lines and diversion boxes needed for receipt of waste from T/TX/TY/U Farms. In addition, removal of waste from the assumed leaking SX Farm tanks will result in a greater curie reduction from SSTs in any farm except A/AX complex.

8.5 Where practical, the waste should be retrieved from non-leaking tank(s) before beginning waste retrieval from an adjacent assumed leaking tank(s).

Basis: The potential for a leak from an assumed leaking tank is assumed greater than the potential for a leak from a sound tank. The leak detection method for an SST during waste retrieval currently (and assumed in the future) is electrical resistivity (ER). This interrogates the soil around the SST for resistivity changes. Changes in the resistivity trend with time may indicate a tank leak. If retrieval activities were being conducted on adjacent assumed leaking and sound tanks and the ER leak detection system indicated a leak in the general area, retrieval activities would be shut down for both tanks until the leaking tank was identified and the impact on the ER sensitivity for the non-leaking tank determined. This could delay retrieval considerably for the non-leaking tank. If retrieval were started in an assumed leaking tank before retrieval began in an adjacent sound tank, and a leak occurred from the assumed leaker, the presence of added liquid in the soil adjacent to the two tanks could prevent waste retrieval in the sound tank until leak migration had reached equilibrium. Retrieving waste from sound tanks adjacent to an assumed leaking tank first will minimize downtime for retrieval.

8.6 For planning purposes assume a maximum of two tanks undergoing retrieval in a farm or farm group at one time until WTP operations are close to starting. After WTP startup the needed infrastructure, DST tank space, and experience are assumed to be in place for up to three simultaneous transfers in East and West area. Additionally, the number of transfers occurring in a year should be constrained to eight.

Basis: There is a practical limit to the number of resources available and to the number of work crews that can operate at the same time within a farm without interfering with each other. There are also practical limits to the transfer lines and receiver tanks available. The additional presence of construction crews will make for more interference. Two simultaneous tank waste retrievals in a tank farm are estimated to be a maximum limit considering safe and effective working conditions as well as transfer lines and receiver tank space. Historically, the most retrievals in one year has been eight.

8.7 A DST or WRF tank should receive waste from only one sludge SST at a time.

Basis: Practical considerations related to operational control of the supernate source tank feed pump for tanks undergoing sludge retrieval by supernate recycling will require a single feed pump per SST undergoing sluicing. Material balance calculations for the simultaneous retrieval of more than one SST to the same DST or WRF tank would also be more difficult than for a single SST pair. Thus, although it is technically possible to send DST/WRF supernate to more than one SST at a time, practical limitations result in a single DST or WRF tank sending supernate to a maximum of one SST at a time. See Assumption 9.20 for limitations with using a WRF tank for sluicing SSTs.

Several tanks containing only saltcake or utilizing water sluicing could be transferred concurrently to a single DST/WRF.

8.8 Where practical, the next tank selected for waste retrieval should not be located adjacent to a tank undergoing retrieval operations unless there is a valid benefit to do so.

Basis: While equipment installation is not precluded on a tank adjacent to a tank undergoing retrieval, the movement of large construction equipment can impact the retrieval activities and leak detection of the tank whose waste is being retrieved. Conversely, the presence of exclusion zones for active waste transfer lines, jersey barriers, exhauster ducting, and other equipment for the tank being retrieved can significantly impact construction on the tank undergoing equipment installation. Restricting installation work to a tank at least one tank space away from a tank undergoing retrieval will reduce impacts to both, and help to maximize the overall rate of waste transfer out of SSTs.

8.9 Deleted. This guideline previously required T/TX/TY and B/BX/BY retrieval to begin with a tank with a ‘moderate’ volume of saltcake to create supernate. Dropping this guideline provides more flexibility as supernate can come from a DST if needed.

8.10 The ^{90}Sr in the sludge being retrieved should be estimated in order to try to maintain the quantity below 2.4E+06 Ci per DST, excluding AY and AZ DSTs. If this isn’t practical with the HTWOS/TOPSIM program, it is recommended that a manual check be performed for the receiver tanks for SX, A, and AX Farm sludge until it is verified that this value is not significantly exceeded.

Basis: The basis for this is heat generation. The primary heat generating radionuclide in tank farms is ^{90}Sr. A quantity of 2.4E+06 Ci will generate a little less than 55,000 BTU/hr. The documented safety analysis (DSA) recognizes that for tanks generating less than 58,000 BTU/hr, a steam bump accident is not of concern. While the

DSTs can reject much more heat than 58,000 BTU/hr, limiting the heat generation rate in a DST to 58,000 BTU/hr (except in AY and AZ tanks) will make operations simpler and easier. The 58,000 BTU/hr maximum applies to AY and AZ tanks also, but these tanks were designed to reject up to 4,000,000 BTU/hr, and with receipt of the waste in A and AX Farms, it is realized these tanks will exceed 58,000 BTU/hr.

8.11 For West Area retrieval, it is recommended to retrieve the waste from SY-101 and SY-103 before any SST waste.

Basis: This provides a DST receipt and transfer system for West Area where two SY tanks are used for waste receipt. When full, the solution is transferred to the third SY tank for cross-site shipment to East Area. Without retrieving the SY-101 and SY-103 waste first, the receipt and transfer of SST waste in West Area will be very inefficient.

8.12 Avoid retrieving the waste from more than one high salt volume + high salt phosphate concentration tank at a time. Space them out to the extent practical.

Basis: The phosphate solution transferred to the DSTs should be spread out to the extent practical to avoid problems with solubility and formation of phosphate crystals. Table B-1 in Appendix B lists the SSTs sorted by saltcake phosphate content. As used here, 'saltcake' refers to saltcake plus saltcake liquid. A high phosphate concentration is assumed for SST retrieval planning to be >2.0 anion mole % phosphate. See Appendix B for definition of anion mole % and Appendix C for 2.0 anion mole % basis.

8.13 There is only one VR-200 or MRS operation at a time in 200 East Area and one in 200 West Area.

Basis: Vacuum retrieval and MRS use significantly more above ground equipment than an ERSS. This equipment is not only more expensive and takes more resources to operate than an ERSS, it takes up a sizeable footprint. With the few tanks planned to use VR-200 and MRS, there will only be one set of VR-200 equipment skids for 200 East Area, and it is realistic to assume that there will only be one set of MRS equipment skids each for 200 East and 200 West Areas.

8.14 When calculating SST retrieval dates, the SS-1647 spreadsheet has the capability to adjust the base RDFs estimated for each process (up to a maximum RDF value given in RPP-40545, Rev. 6). This feature is useful for sensitivity analyses and allows different mission completion end dates to be estimated based on assumed improvements in retrieval efficiencies.

Basis: The base RDFs calculated in RPP-40545 Rev. 6 for the retrieval processes are low, in the range of 24 to 41%. Such low efficiencies, if not significantly increased, result in completion of SST retrieval operations beyond an acceptable date.

The SS-1647 spreadsheet that calculates retrieval durations has a manual iteration built in that permits application of multiplication factors to the base RDF for each retrieval process to increase the RDF and thus decrease the calculated retrieval duration. If the RDFs are to be brought up to the nominal 60% or higher range usually applied to operating facilities, the base RDFs must be increased by multiplication factors of 1.5 to 2.5, depending upon the process.

How efficiency improvements are obtained is beyond the scope of this document, but presumably would be accomplished with a combination of technical and administrative changes. An improvement to the degree required will be neither easy nor quick. It will take a significant and extended focus to resolve.

9.0 BOUNDING ASSUMPTIONS FOR SINGLE-SHELL TANK WASTE RETRIEVAL PLANNING

This section delineates the bounding assumptions for SST waste retrieval planning for this document. Deleted assumptions are assumed to be resolved or are no longer applicable.

9.1 Fundamental changes are made in how work is performed within tank farms that will increase the base RDFs for waste retrieval processes by the multiplication factor(s) determined by Guideline 8.14.

Basis: RPP-40545, Rev. 6, develops base RDF values for each retrieval process. Factors considered in development of the RDFs included shift schedule, maintenance and repair downtime, weather, unexpected tank conditions, lack of resources, administrative requirements, environmental agreements, nuclear safety and engineering requirements, and downtime due to a retrieval tank leak. The calculated base efficiencies are low, in the range of 24 to 41% depending upon retrieval process, assuming an ABCD shift operation.

Such low efficiency, if not significantly increased, will stretch out SST retrieval beyond desired end dates. Changes are needed to significantly increase either the retrieval process efficiencies or the SST retrieval transfer line sizes, pumping flow rates, and volume of supernate present in the supernate feed tank during sludge sluicing.

The choice of what to do to provide an acceptable SST retrieval end date reduces to either eliminating roadblocks to efficiency or accepting the roadblocks and compensating for them with bigger equipment. The recommended alternative is to reduce the roadblocks.

Operating with very low efficiencies is possible if physical changes are made to increase the size of SST retrieval equipment to compensate for the low operating percentage. The primary changes would be 3-in. transfer lines and larger pumps. However, use of 3-in. HIHTLs (with a 6-in. outer hose) instead of the current 2-in. HIHTLs with a 4-in. outer hose would make line installation more difficult and require more shielding. Physical limitations with pump dimensions and riser diameters would necessitate either adding larger diameter risers to tanks in B/BX/T/U Farms, or adding above ground booster pumps with new above ground pits. Safety basis issues related to potential transfer leak accidents would be involved with the larger pump and line sizes. Larger pumps and transfer lines were used in past tank farm operations from the 1940s through the 1980s, but the current tank farms safety analysis is based upon the smaller pumps and transfer lines currently used. Changing to larger pumps and lines will result in significant administrative and equipment costs. Some of the pump designs currently deployed in tank farms may require the addition of new and larger risers to some tanks if the pump size is increased. Use of larger pumps and line sizes would also require a very significant redesign of the MARS system, and possibly be impractical for MARS use.

Therefore, improvement of the RDFs is recommended. Reduction of roadblocks, with one exception, requires fundamental changes in conduct of engineering and operations in the Hanford tank farms and is beyond the purview of this document. See Assumption 9.21 for the one exception to improve the RDF.

See Requirement 11.9 on RDF improvement.

9.2 Waste retrieval from each farm will use diversion boxes, transfer lines, and interim receipt facilities similar to the description in Appendix D.

Basis: A conceptual design has not been performed covering the infrastructure required for retrieval of all SSTs. The information in Appendix D is based on engineering judgment.

9.3 Electrical power, lighting, and water upgrades are made to each farm before needed so required upgrades do not impact retrieval construction activities.

Basis: This is a reasonable assumption that assumes funding is provided so upgrades can be performed prior to the time that old equipment removal and retrieval equipment construction begin in a tank farm.

9.4 Facility design, old equipment removal, new equipment construction, installation of any new risers, acceptance testing, and startup approval documentation are planned and completed so that retrieval operations are ready to proceed on a tank when ready, within the limits of time given by other constraints. The RDF assumptions in RPP-40545 attempt to account for delays which may occur following the start of retrieval operations, but there are no delay assumptions for pre-retrieval design and construction delays.

Basis: This is an idealistic assumption, but building in assumed pre-retrieval schedule delays is not included as part of SST retrieval planning.

9.5 The CH-TRU facility can handle water or recycled supernate transferred in with the waste solids, and ERSS retrieval rates can be balanced with the CH-TRU processing rate.

Basis: This assumption is not completely consistent with the draft conceptual design for the CH-TRU processing facility, which assumes the CH-TRU waste is retrieved using

VR-200 or MRS. This assumption will impact the liquid/solid separation stage at the CH-TRU facility and may impact the overall waste drying and packaging stages. The CH-TRU draft conceptual design currently assumes the incoming waste is only passed through a low-temperature vacuum dryer. The CH-TRU facility liquid/solid separation stage could be redesigned to handle ERSS slurries rather than VR/MRS slurries, and the SST retrieval system designs can be scaled back, or the shift operating schedules can be cut back to meet the CH-TRU waste throughput rates.

9.6 Waste retrieval will proceed until the tank waste level is below the HFFACO residual volume limit and the limits of technology met for all tanks.

Basis: Excluding A-105, there is no definite basis at this time to state which tanks may not be able to successfully meet the HFFACO limit. Individual problems that may occur will be addressed as the situation arises. Tank A-105 will be problematical with the majority of the waste under the ruptured liner. Retrieval planning conservatively assumes this volume is either removed, or that the risk associated with it remaining is addressed in the tank waste retrieval work plan (TWRWP) for the tank.

9.7 Deleted.

9.8 Once the residual waste volume is below the HFFACO limit and the limits of technology have been met for an SST, retrieval is complete. No impact is included for meeting limits on curie content or stricter residual waste volume criteria.

Basis: There is no basis at this time to assign stricter risk-based criteria to a tank residual waste volume, in part because it is unclear what those criteria would be. Following retrieval, a performance assessment is required to address groundwater protection and tank intrusion. As identified in Appendix H of the HFFACO, the U.S. Nuclear Regulatory Commission must agree on the closure actions and allowable waste residuals. Because of the uncertainty of the constituent concentrations in the heel and the lack of any existing definite risk-based criteria, no risk-based criteria are used for prediction of tank retrieval completion.

9.9 Deleted.

9.10 Deleted.

9.11 Deleted.

9.12 It is assumed that the equipment designs used for VR-200 and MRS retrieval are revised to enable effective retrieval rates.

Basis: The VR-200 system used for C-200 retrieval was ineffective, despite operating satisfactorily on a waste simulant during cold testing. The ineffectiveness is believed due to limitations in the mast head design and/or the vacuum line length. The inability to adequately cool the vacuum blower seal water also significantly impacted the operation.

The retrieval parameters in RPP-40545 Rev. 5 for VR-200 and MRS retrieval are based upon the assumption that these operational problems are resolved.

9.13 The downcomers on the central 42-in. risers for the six A Farm tanks can be successfully removed where needed.

Basis: Each of the A Farm tanks has a 42-in. diameter pipe that extended from the top of the center riser down to within 20 ft of the tank bottom at the time of installation. This spacing will be less if a tank bottom has bulged upwards during waste storage. Tank bulges have occurred in several SSTs that contained high heat sludge, the worst case being A-105 with a nominal 8 ft. off-center bulge. Use of a MARS-S or MARS-V system in a C Farm tank requires a minimum of 15 ft of space below the riser to install the MARS equipment. It is assumed that a similar or greater clearance will be required for the deeper A Farm tanks. Removal will require development and testing of a downcomer cutting method that can be employed in these tanks. See Requirement 11.8.

9.14 It is assumed that large diameter holes can be cut as needed into the domes of tanks in B, BX, T, and U Farm to permit installation of a MARS-V (or MARS-S) unit into these tanks.

Basis: One hole was cut into C-107 in late 2010 using garnet and another was cut in C-105 rotary hole coring method. The hole coring method was developed because Ecology raised concerns over the addition of garnet used to cut the holes to the SST waste. This concern is based upon erosion that spent garnet is theorized to cause on processing equipment in the WTP. External letter 00091809, *Department of Ecology (Ecology) Approval of the Hanford Federal Facility Agreement and Consent Order (HFFACO) Modification Notice Number 20 10-4, for RPP-22393, Revisions 4B, 241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan (TWRWP)*, states DOE may cut up to three holes in C Farm tank domes (providing specific documentation is provided to Ecology in advance), but goes on to state:

> *…At this time, the review of impacts from the garnet on the WTP is not sufficient to support the proposed use of garnet for more than the three planned tanks in C Farm. In order to use the garnet cutting materials beyond the tanks in C Farm, the United State [sic] Department of Energy (USDOE) will need to verify the garnet impacts. This may include performing further erosion testing, recalculating wear allowances with test specific garnet data, and detailed analysis of each equipment piece that will transport garnet related waste (pumps, valves, filters, etc.).*

There is little realistic basis to suspect there would be any noticeable additional erosion problems in the WTP with the extremely small concentration of garnet in the SST waste. In addition, the garnet particles are worn down in the process of cutting through the nominal 15 in. of concrete, which should further reduce the small potential for WTP impact. With the rotary hole coring method available dome cuts can be made as necessary to support retrieval operations.

9.15 It is assumed that all MARS-V arms deployed after C Farm will fit into a 42-in. central riser.

Basis: The MARS design was originally intended to fit into a 42-in. riser on a tank. The initial MARS-S design was for an arm with a maximum outside diameter of ~41.5 in. During testing of the first arm it was decided that the arm design needed to be strengthened, which resulted in the maximum arm outside diameter slightly exceeding 42 in. RPP-SPEC-39989, *Performance Specification for The Mobile Arm Retrieval System for Tank 241-C-107,* Rev. 2, the specification for the MARS-S unit installed in C-107, called for the new riser installed on that tank to be a minimum 42-in. diameter. RPP-SPEC-47363, *Performance Specification for the Vacuum Mode Mobile Arm Retrieval System for C-Farm Tank 241-C-105,* Rev. 1, the specification for the MARS-V unit installed in C-105, also calls for the new riser installed on that tank to be a minimum 42-in. diameter. A nominal 55-in. hole cut was made for C-107 and a 47-in. inside diameter riser installed on that tank. The same size hole cut and new riser were used in C-105. The tanks in B/BX/ T/U Farms which will use a MARS-V can have a similar riser installed to accommodate a MARS arm somewhat greater than 42-in. outside diameter. However, for the tanks in A/BY/S/SX/TX/TY Farms assumed to use MARS-V arm and which already have a 42-in. riser installed, it would extremely inefficient to remove the existing riser and install one slightly larger. It will take redesign work to ensure a MARS-S or MARS-V will fit into a 42-in. riser, but the assumption is made that such a redesign can be achieved.

9.16 It is assumed that a process can be developed to either remove the salt embedded ALCs from the 42 in. central risers in assumed leaking tanks BY-103, TX-105, TX-110, and TX-114 or cut off the upper portions and either remove them or let them fall into the tank, to enable a MARS-V arm to be installed in the tanks and work above and around the ALC lower portions.

Basis: It is assumed these obstacles can be overcome with appropriate effort and thought. Requirement 11.1 calls for evaluation of this problem and development of a solution early to resolve it long before retrieval design is required, so there is time to develop alternate solutions if needed.

9.17 It is assumed that a structural analysis can be done to show the TX-117 dome will support the weight of MARS-V system, or that a suitable support pad or structural support can be designed to support the units for these tanks.

Basis: It is possible that structural analyses could show the radial cracks will not impact the MARS-V dome loading for TX-117, but even if there are impacts it is assumed a support mechanism can be designed and built that will provide the necessary support. Requirement 11.2 is to evaluate these problems and develop a solution early to resolve them before retrieval design is required.

9.18 It is assumed that a MARS-V system will fit in A-105 with the bulged liner.

Basis: The A-105 floor mapping done in 1978 (see Appendix E) indicates there should be several feet of clearance under a MARS-V, if it had the same dimensions as a MARS unit for C Farm and the 42 in. downcomer was not removed. With the downcomer removed (see Assumption 9.13) there should not be any clearance problem for a MARS-V in A-105.

9.19 It is assumed that supernate can be used where practical for sluicing with a MARS-V system in assumed leaking tanks.

Basis: Supernate is preferred over water because sluicing with only water would put a significant load on the DST system for storage and on the evaporator for boil-off. The downside to using supernate is that it may have soluble constituents (currently assumed to be ^{99}Tc, Cr, and NO_2) that could pose more risk to the groundwater should solution leak during retrieval. It is assumed supernate is acceptable to use because retrieval operations can be performed to minimize liquid in the tank with the MARS-V, supernate solutions can, in some instances, be selected that have lower soluble hazardous constituents, and even with water sluicing of sludge the water will pick up soluble constituents from the sludge and the sludge interstitial liquid. See Recommendation 10.6.

9.20 It is assumed that the current WRF plan with six 150 kgal tanks will work for sludge sluicing, or that changes can be made in the design so that it will be effective.

Basis: Sludge sluicing currently is performed by pumping supernate from a storage tank to the SST to mobilize the sludge, pumping the resulting slurry back to the storage tank, having the sludge settle, and pumping clarified supernate off the top back to the SST to mobilize more waste. With the nominal 95 gpm slurry pumping rates used during sluicing, retrieval experience has shown that about a 2-3 day residence time is needed for sludge to settle in the 75 ft. diameter DSTs used for slurry receipt. When a 150 kgal tank is used for sludge sluicing instead of a million gal DST there is insufficient residence time for sludge to settle. This will likely require 2 to 3 of the WRF tanks to be filled with supernate with the sludge slurry from the SST going to a different WRF tank instead of the supernate supply tank. When a WRF tank is filled with sludge slurry in a day or so it will need to be pumped immediately to a DST. Such a process will require recycle of supernate back from a DST to the WRF or continual generation of dissolved salt solution from another SST. This can be done but the logistical problems may make such a process idealistic. It is assumed the process for sludge sluicing to a WRF tank can be resolved in conceptual design, see Requirement 11.3.

9.21 It is assumed that agreement can be reached with Ecology to proceed as quickly as possible, following pre-agreed upon guidelines for tanks to proceed with retrieval expeditiously following confirmation of an SST leak during retrieval.

Basis: Requirements in the AX Farm TWRWPs call for halting retrieval operations following detection of a leak and engaging in discussions with Ecology as to how to proceed. Experience has shown that such discussions may be drawn out and result in considerable delay. In the event of a leak the most viable procedure to minimize a release of SST waste to the soil is assumed to be to continue with retrieval as fast as possible while minimizing liquid in the tank, and performing retrieval operations in areas of the tank believed to be away from the leak location. It is assumed that TWRWPs for future tanks will include agreement to proceed with retrieval as quickly as practical following a leak to eliminate such delays. See Requirement 11.10.

9.22 It is assumed that the retrieved waste volume sent to the DST system from tanks with high concentrations of phosphate in the salt phase can be adequately estimated using the parameters in RPP-40545, Rev. 6, until better estimating methods are developed.

Basis: Current requirements for transfer of high phosphate salt solutions are inadequate for retrieval planning use. See Requirement 11.5 for explanation and proposed solution.

9.23 It is assumed that for all ERSS retrieval operations, equipment for HTRH removal will be available during bulk retrieval operations. All above grade HTRH removal equipment is installed to the extent practical prior to the end of bulk retrieval, and the remaining equipment installed and operated in the SST as soon as the waste slurry concentration drops below a predetermined point. Bulk retrieval operations will not proceed to the point where the limit of technology is reached for modified sluicing before halting work and installing the HTRH removal equipment.

Basis: Designing and installing above grade HTRH removal equipment before it is needed and installing the in-tank equipment as soon as the waste slurry concentration drops below a preset level (see RPP-40545, Rev. 6, Appendix A for assumed concentrations) reduces the time required for sludge and saltcake removal and reduces the waste volume generated for saltcake removal. See Recommendation 10.9.

9.24 This assumption has been deleted. The deep bed sludge flammable gas issue has been resolved.

10.0 RECOMMENDATIONS TO MAXIMIZE POTENTIAL TO MEET HFFACO MILESTONE M-24-70 FOR SST RETRIEVAL COMPLETION

This section lists recommendations for improving the ability to retrieve tanks when planned and to minimize or eliminate problems that impact retrieval timing and the ability to complete SST retrieval by the date specified in HFFACO Milestone M-45-70. Deleted recommendations have been resolved or are no longer applicable.

10.1 Proceed with utility upgrades for all SST farms awaiting retrieval.

Basis: These upgrades are necessary before retrieval, and the electrical, lighting, and water upgrades will be required prior to performing most equipment removal operations. Utility upgrades can begin whenever resources are available; there is no need to wait for DST space to become available after WTP startup.

10.2 Implement removal of all in-tank equipment requiring removal prior to retrieval in a tank farm so the tanks are prepared for equipment installation far in advance of the time needed.

Basis: Removing the equipment early will significantly reduce the construction duration for each tank retrieval and will permit identification and resolution of most unanticipated problems before they can impact retrieval equipment installation. Equipment removal can begin whenever resources are available; there is no need to wait for DST space to become available after WTP startup.

10.3 Proceed with design and construction of new transfer lines from B/BX/BY to an East Area DST farm and from T/TX/TY to SY Farm, with a new diversion box by U Farm.

Basis: These lines are mandatory before retrieval can be performed beyond A/AX or S/SX Farms. Installation of these lines is not held up by WTP startup, these lines can be installed when resources are available so they are ready before the time they are needed.

10.4 Reevaluate the tanks designated as assumed leaking tanks in Table 10-1 to determine which can be re-categorized as sound, or sound below a given waste level.

Basis: The tanks listed in Table 10-1, except for B-105, are all either MARS-V tanks to which new 42-in. central risers have to be added, MRS tanks, or VR-200 tanks. It is highly desirable from both economic and retrieval duration standpoints to minimize the number of tanks using MRS/VR-200 or needing a new large central riser.

B-105 is shown as using ERSS-HPW even though it is designated an assumed leaker. The geometry of the saltcake in this tank makes ERSS the best option for retrieval. This is discussed in Section 6 for Decision Point 15 and in Appendix E. A reevaluation of the tank status is desirable to justify using ERSS for this tank.

BY-105 is shown in Tables 6-1 and 6-2 as using a MARS-V. Due to the concrete layer(s) in this tank, an ERSS may be more effective in concrete removal and should be used if the tank can be re-categorized as sound.

Any of the tanks planned for MRS or for a new central 42-in. riser that can be re-categorized to sound (or with an analysis that shows any leaks were above the current waste level in the tank) could use an ERSS for retrieval. The first 13 tanks in Table 10-1 are among 19 ‘questionable integrity’ tanks that were re-categorized as assumed leakers without any specific information indicating the tanks leaked.

Table 10-1. Assumed Leaker Tanks Recommended for Reevaluation

Tank	Waste Volume (kgal)	Retrieval Process from Table 6-1
B-101	104.9	MARS-V – new riser
B-103	38	MRS
B-105	245.7	ERSS-HPW
B-110	244.1	MARS-V – new riser
B-111	215.6	MARS-V – new riser
B-112	34.1	MRS
B-201	29.6	VR-200
B-203	50.2	VR-200
B-204	49.4	VR-200
BX-101	51.5	MRS
BX-102	88.8	MARS-V – new riser
BX-108	29.9	MRS
BX-110	212.4	MARS-V – new riser
BX-111	118.1	MARS-V – new riser
BY-105	440.6	MARS-V
BY-106	385.7	MARS-V
BY-107	247.8	MARS-V
BY-108	201.6	MARS-V
T-103	26.4	MRS
T-107	167	MARS-V – new riser
T-108	15.1	MRS
TX-105	423.2	MARS-V
TX-110	376.2	MARS-V
TX-113	558.2	MARS-V
TX-115	455.2	MARS-V
TX-116	488.5	MARS-V
TX-117	547.6	MARS-V
TY-101	99.9	MARS-V
U-101	30.9	MRS

U-101 was designated as a leaking tank back in 1959. An in-tank video taken during sampling activities in the mid-90s showed liquid present on the tank bottom. This leads to the assumption that the leak location may have been above the current waste level and that an ERSS could possibly be used if the leak could be shown to be above the current liquid level.

RPP-32681 evaluations for Tanks T-111, U-104, U-110 and U-112 and the integrity assessment for T-103 concluded that these tanks should remain designated as “assumed leakers.”

Integrity evaluations for the tanks identified in Table 10-1 should demonstrate that a fair number of them can be re-categorized as sound, or sound if the waste level is kept below a given level during retrieval. Reevaluation will permit use of an ERSS in the re-categorized tanks. Table 6-1 indicates 7 tanks will require a new large (nominal 47 in.) central riser. If all the tanks listed in Table 10-1 as requiring a new 42-in. riser could be shown as sound, only 3 tanks would require a new large riser to be installed (T-111, U-110, and BX-102).

10.5 When designing the WRFs that will be located near B/BX/BY Farms in 200 East Area and T/TX/TY Farms in 200 West Area, consideration should be given to providing one or both of the facilities with a stainless steel-lined room that can be used for decontamination and repair of tank farm equipment, and where new and used transfer pumps can be received, repaired, and stored.

Basis: All chemical processing facilities at Hanford had locations for decontamination and repair of equipment, and for contaminated equipment storage until reuse. Tank Farms does not have that capability, although in the distant past some pump motors were replaced in the field or locations were found where work could be done on a very limited basis in other 200 Area facilities. Pump failures currently require removal and disposal of the pump. Even small items like video cameras which are contaminated are normally disposed of because of the lack of places to repair them. When retrieval operations are going around the clock after the WTP is operational, steps must be taken to increase the RDF (see Assumption 9.1). A significant factor in the low RDF is the downtime to deal with failed pumps or other equipment.

Building a new facility for decontamination, repair, and storage of used pumps and other equipment would be expensive and hard to justify as a standalone facility. The WRFs are required for retrieval operations, and the cost to add on decontamination, repair, and storage capability to a WRF should be significantly less than the cost for a standalone facility because ventilation, personnel access, waste handling, and related requirements for the facilities would be shared. Providing such capability to one or both WRFs should be evaluated in the WRF designs and included if economically justifiable.

10.6 The potential groundwater impact with use of supernate for sluicing with MARS-V in assumed leaking tanks should be evaluated to address concerns that may be raised in the future.

Basis: Assumption 9.19 is that supernate can be used as planned for the MARS-V. Evaluation of any potential risk in advance can minimize concerns raised later. The TWRWPs all include appendices that evaluate the risk of a tank leak during retrieval to address this subject. However, it is recommended this evaluation be done in advance of TWRWP preparation (for tanks using the MARS-V after C-105) so as to resolve the potential issue before design has begun.

10.7 The tank sampling, saltwell pumping, or LOW information listed in Appendix F is reviewed and additional tank core sampling is performed where deemed prudent.

Basis: Where no physical data are available for a tank waste templates have normally been used to estimate BBI composition. Core sampling will not only provide better constituent data, the sampling process itself provides valuable information on the waste physical properties and condition. It is highly desirable to get such information in advance to minimize surprises when retrieval is attempted.

10.8 The MRS process should be reevaluated to try and eliminate the above ground skids.

Basis: The MRS is the current alternative for the MARS-V process in B, BX, C, T, and U tanks with low waste volume. The MRS is preferred over cutting a new large central riser for these tanks, but the above ground skids coupled with the batch process present problems with personnel exposure, slow retrieval rates, and safety basis aerosol issues. Elimination of the above ground skids would simplify retrieval and may permit expansion of the MRS process to more tanks, with concurrent elimination of cutting large diameter holes in tank domes.

10.9 Deleted.

10.10 Deleted.

10.11 HTWOS/TOPSIM planning should evaluate the impacts on retrieval schedule assuming only one tank at a time in 200 East Area and one at a time in 200 West Area is being retrieved.

Basis: Guideline 8.6 is to assume a maximum of two tanks undergoing retrieval in 200 East Area, excluding C Farm, and a maximum of two at a time in 200 West Area for HTWOS/TOPSIM planning. Limitations on number of receiver tanks will restrict A/AX retrievals and may restrict S/SX/U retrievals to one at a time from these groupings. Whether more than one tank could be retrieved at a time in B/BX/BY and T/TX/TY groups will depend upon the number of transfer lines available and WRF operations. It is highly desirable from a planning standpoint to bind the retrievals to one at a time for each area to indicate a worst case scenario, and provide support for estimating the number of transfer lines required to the DST receiver tanks.

11.0 REQUIREMENTS TO RESOLVE SST RETRIEVAL PLANNING UNKNOWNS AND/OR TO IMPROVE THE PLANNING PROCESS

Deleted requirements have been resolved or are no longer applicable.

11.1 A method needs to be developed to remove the ALCs embedded in salt located in the 42 in. central riser of assumed leaking tanks in BY and TX Farm, or enable them to remain in place with a MARS-V system installed in the tank.

Basis: Assumption 9.16 is that a removal method can be developed that will enable MARS-V installation and operation in these tanks. The sooner such a method is developed the more confidence there will be in the retrieval planning process.

11.2 Methods need to be developed to provide support for a MARS-V unit in TX-117 with the cracked domes in the tanks.

Basis: Assumption 9.17 is that designs can be developed to support the weight of MARS-V units for this tank.

11.3 A workable process must be defined for sludge sluicing using WRF tanks.

Basis: See Assumption 9.20. The sooner a process is defined for sludge sluicing using the WRF tanks the easier it will be for conceptual design to proceed for both WRFs.

11.4 The Baseline cost through the end of SST retrieval needs to be updated to include the processes in this document and the estimated schedule in the latest System Plan.

Basis: The need is self-evident, the Baseline cost estimate should reflect the latest planning.

11.5 Engineering work needs to be conducted to derive an acceptable concentration (or combination of concentration and other transfer parameters) for phosphate in dissolved salt solutions sent to the DST system. The sooner this work is done the more confidence there will be in estimated retrieval volumes.

Basis: TFC-ENG-STD-26, 2011, *Waste Transfer, Dilution, and Flushing Requirements*, Revision C-2, requires transferred salt solutions to be <9.5 g/L phosphate, or to have the transfer analyzed to minimize problems with line pluggage due to the phosphate crystals that can form and plug the line. Limiting solutions to 9.5 g/L phosphate will result in excessive volumes of solution generated during salt dissolution from a number of SSTs. Salt solution removed from S-102 during retrieval appears to have had an <u>average</u> phosphate concentration considerably in excess of 9.5 g/L with no transfer line pluggage problems (the pump inlet pluggage that resulting in shutting down S-102 retrieval in 2007 was a different issue).

RPP-40545, Rev. 6, has a number of assumptions that attempt to deal with the phosphate problem, one of these being the use of a WDF. Salt is assumed dissolved following equations in the document and the resulting volume is divided by the WDF to give an estimated total dissolved salt solution volume.

Tank S-102 had a salt phosphate concentration approximately 10 times that of S-112. Table B-1 in Appendix B shows 17 of the SSTs have salt phosphate concentrations greater than S-102, with the highest being about 8.5 times that of S-102. The maximum WDF used in RPP-40545, Rev. 5 gives a salt solution volume about 1.8 times that for salt with a composition similar to S-102. Using a WDF of up to 8.5 times that of S-102 could result in unacceptable volumes of liquid being sent to the DST system. An engineering study, along with supporting lab or pilot plant data, is required to provide acceptable guidelines for retrieval of high phosphate salt wastes that can be used for future retrieval planning.

11.6 Proceed with garnet erosion testing to estimate wear on WTP equipment.

Basis: This testing is necessary to close out a requirement from Ecology that limits cutting of nominal 55 in. diameter holes in SST domes. Table 6-1 indicates 10 holes will be needed for installation of MARS-V units. Additional holes will be required if the MRS system is not used.

11.7 Deleted.

11.8 Proceed with development of a method for cutting off the 42 in. downcomers in the A Farm SSTs.

Basis: Cutting off these downcomers is a requirement for use of a MARS-V system in some, and possibly all, the A Farm tanks. Development of a process will take time and if deferred until A Farm retrieval design is begun unacceptable delays could result. See Appendix E for a discussion of this problem and a proposed solution.

11.9 The TOC and the DOE need to evaluate the low efficiencies experienced with past waste retrieval operations, and estimated to occur in the future, and implement a solution.

Basis: The RDF for retrieval operations must be improved if HFFACO Milestone M-45-70 to complete SST retrieval by September 30, 2040 is to be met. There have been attempts in the past to improve work efficiency by reducing bottlenecks, but negligible improvement has resulted because few requirements or paradigms have been changed. Changes need to be made at the fundamental level in order to succeed with retrieval.

11.10 Obtain agreement with Ecology to proceed as quickly as possible with retrieval should a tank appear to leak during the retrieval process.

Basis: See Assumption 9.21 basis.

12.0 USE OF SOUND SINGLE-SHELL TANKS FOR TEMPORARY STORAGE OF WASTE RETRIEVED FROM OTHER SINGLE-SHELL TANKS

Use of a limited number of sound SSTs for waste staging is not included in this SST retrieval plan. This option may have technical merit and could reduce the overall SST retrieval duration by reducing the schedule limitations caused by lack of DST storage space. However, approval from the Washington State Dept. of Ecology would be required before such a plan could proceed, and the time and funding expended to obtain regulatory approvals for waste staging may offset the schedule benefit. Any SST retrieval planning that includes SST waste staging should not be a part of the baseline until regulatory approvals have been resolved.

A primary physical restriction to current SST retrieval is the lack of DST storage space. An improvement to the SST retrieval schedule for some tanks might be realized if sound SSTs were used to provide limited staging of retrieved SST wastes until DST space became available. The methodology and requirements for retrieving a number of assumed leaking SX Farm tanks into sound SSTs was evaluated in FY 2010, along with a scoping level evaluation of performing similar actions in U, T, TX, TY, B, BX, and BY Farms. The retrieval of SST waste into sound SSTs is described in RPP-RPT-47282, *Data to Support the Regulatory Evaluation of Single-Shell Tank Waste Staging*, and RPP-RPT-48221, *Data Package for Single-Shell Tank Waste Staging*. The potential for a reduction in SST retrieval duration warrants the attempt to obtain Ecology agreement on the proposed plan, providing the benefit of doing so can be established.

13.0 LEGAL DRIVERS FOR SINGLE-SHELL TANK RETRIEVAL PLANNING

The primary legal drivers which impact SST retrieval planning are the HFFACO and Consent Decree.

Consent Decree requirements impacting SST retrieval planning are discussed in Section 6 (Decision Point 8) and Section 8 (Guideline 8.2).

The HFFACO milestones which most affect SST retrieval planning are M-45-15, M-45-70, M-062-40, and, by relation to M-062-40, the M-45-91 series milestones related to SST integrity. Impacts of M-45-15 and M-45-70 are discussed in Sections 2, 8.14, and 9.1.

Per HFFACO Milestone M-062-40, the system plan will consider, for SST retrieval (note that these are not the only items to consider listed under M-062-40, but the omitted items are not directly related to SST retrieval):

- *SST integrity information, including the SST integrity assurance review provided under milestone M-045-91 and any further integrity assessments.*
- *Waste retrieval rate sufficient to operate all waste treatment facilities at their full capacities, considering optimized waste feed rates.*

- *The effect of the waste retrieval technologies selected through the TWRWP process on waste retrieval rates.*

The system plan will also take into account the results from previous waste retrievals and other waste treatment studies. This shall include:

- *The retrieval methodologies that could be employed and estimated waste volumes to be generated for transfer to the DST or other safe storage.*
- *Proposed improvements to reduce waste retrieval durations.*

The system plan will identify and consider possible contingency measures to address the following risks:

- *Results from SST integrity evaluations.*
- *If retrievals take longer than originally anticipated and there is potential impact to the schedule for retrieving specified tanks under this agreement.*

While SST integrity information is not used directly in the SST retrieval plan, any input from the SST Integrity Panel would likely impact SST retrieval if waste staging is included in future SST retrieval plans. Any recommendations from the panel, or related input that may affect a tank's sound or assumed leaker status could affect the type of retrieval process selected for a tank.

Estimated waste retrieval rates for all selected retrieval processes are provided in RPP-40545.

Selected retrieval processes are given in Section 6.0 of this document. Estimated waste retrieval volumes are provided in SS-1647.

The potential for retrieval operations to take longer than originally anticipated is related to a variety of factors. The impact of low RDFs is addressed in Sections 2, 8.14, and 9.1 of this retrieval plan. The estimated HTRH and Transition Region start volumes, waste difficulty factors, tank restriction factors, and base RDFs provided in RPP-40545 attempt to enable estimation of retrieval volumes and durations to the extent practical at this time.

14.0 REFERENCES

89-10, Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement,* 2 Volumes, as amended (September 29, 2011 is latest version as of issuance of this document), State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Consent Decree collectively refers to the Consent Decree in Case No. 2:08-cv-05085-FVS (October 25, 2010), the Amended Consent Decree, Case No. 2:08-cv-05085-RMP (March 11, 2016), and the Second Amended Consent Decree, Case No. 2:08-cv-05085-RMP (April 12, 2016) and the Third Amended Consent Decree, Case No. 2.08-cv-05085-RMP (October 12, 2018). The TWRWP requirements of the October 25, 2010 Consent Decree were not modified by either the Amended Consent Decree or the Second Amended Consent Decree.

HNF-EP-0182, 2020, *Waste* Tank *Summary Report for Month Ending June 30, 2020*, Rev. 390, Washington River Protection Solutions LLC, Richland, Washington.

H-2-39599, 1954, *241-SX* Waste *Self-Concentrator Test Facility*, Rev. 0, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

Letter, J. J. Lyon, Washington State Department of Ecology, to R. J. Schepens, ORP, "Use of Double Shell Tank AN-106 Supernate for Waste Retrieval from Single-Shell Tanks (SST) 241-C-103 and 241-C-105," 0402254, dated July 22, 2004.

Letter, J. J. Lyon, Washington State Department of Ecology, to D. A. Brockman, ORP, "Department of Ecology (Ecology) Approval of the Hanford Federal Facility Agreement and Consent Order (HFFACO) Modification Notice Number 20 10-4, for RPP-22393, Revisions 4B, 241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan (TWRWP)" 0091809, dated November 5, 2010.

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

RPP-16525, 2006, *C-200 Series Tanks Functions and Requirements*, Rev. 6A, CH2M HILL Hanford Group Inc., Richland, Washington.

RPP-32681, 2007, *Process* to *Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-40545, 2021, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-38219, 2008, Tank *241-C-110 Leak Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-ASMT-38450, 2008, Tank *241-SX-104 Leak Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-ASMT-39155, 2008, Tank *241-C-111 Leak Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-ASMT-42278, 2009, Tank *241-A-103 Leak Assessment Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-47140, 2010, Tank *241-SX-110 Leak Assessment Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-46452, 2010, Tank *241-C-105 Leak Assessment Completion Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-48143, 2011, Tank *241-SX-104 Leak Assessment Completion Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-62316, 2018, Leak *Assessment Report for Tank 241-S-104*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-62935, Rev. 0, *Leak Assessment Report for Tank 241-T-101,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ASMT-63776, 2020, *Leak Assessment Report for Tank 241-T-109,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ENV-33418, 2011, *Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105 and Unplanned Waste Releases,* Rev. 2, Washington River Protection Solutions LLC, Richland, Washington.

RPP-ENV-37956, 2008, *Hanford A and AX-Farm Leak Assessments Report: 241-A-103, 241-A-104, 241-A-105, 241-AX-102, 241-AX-104 and Unplanned Waste Releases,* Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-ENV-39658, 2010, *Hanford SX-Farm Leak Assessments Report,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-26475, 2008, *Retrieval Data Report for Single-Shell Tank 241-C-203*, Rev. 1A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-29095, 2006, *Retrieval Data Report for Single-Shell Tank 241-C-202*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-30181, 2006, *Retrieval Data Report for Single-Shell Tank 241-C-201*, Rev. 0B, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-34062, 2007, *Retrieval Data Report for Single-Shell Tank 241-C-204*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-47282, 2010, *Data to Support the Regulatory Evaluation of Single-Shell Tank Waste Staging,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-48221, 2010, *Data Package for Single-Shell Tank Waste Staging*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-48589, 2011, *Hanford 241-S Leak Assessment Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-SPEC-39989, 2010, *Performance Specification for the Mobile Arm Retrieval System for Tank 241-C-107*, Rev. 2, Washington River Protection Solutions LLC, Richland, Washington.

RPP-SPEC-47363, 2010, *Performance Specification for the Vacuum Mode Mobile Arm Retrieval System for C-Farm Tank 241-C-105*, Rev. 1, Washington River Protection Solutions LLC, Richland, Washington.

SS-1647, 2021, *Single-Shell Tank Retrieval Assumptions for Mission Modeling*, Rev. 1, Washington River Protection Solutions LLC, Richland, Washington.

SS-2404, 2021, *Calculation of Selected SST Retrieval Parameter*s Rev. 1, Washington River Protection Solutions LLC, Richland, Washington.

TFC-ENG-CHEM-D-42, 2017, *Tank Leak Assessment Process*, Rev. B-12, Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-CHEM-P-57, *Intrusion Notification and Leak Assessment Process,* latest revision, Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-STD-26, 2011, *Waste Transfer, Dilution, and Flushing Requirements*, Rev. A-9, Washington River Protection Solutions, LLC, Richland Washington.

APPENDIX A –
OVERVIEW OF SINGLE-SHELL TANKS AND SINGLE-SHELL TANK WASTE

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Abbreviations and Acronyms

BBI	Best-Basis Inventory
IL	interstitial liquid
SST	single-shell-tank
TWINS	Tank Waste Information Network System

A.0 OVERVIEW

There are 149 tanks at Hanford classified as single-shell tanks (SSTs). These tanks are located in 12 tank farms: six farms are located in 200 East Area and six are in the 200 West Area. The solid wastes stored in these tanks are sludge or saltcake. The wastes consist of dried solids or solids containing interstitial liquid (IL), with minor amounts of retained gases and free (i.e., above the waste solids) liquid. The wastes in the SSTs were generated during chemical processing activities conducted from 1944 through 1980. Sludge wastes are insoluble compounds, most of which were precipitated when the solutions generated in the processing plants were neutralized prior to being transferred to tank farms. Salt wastes are soluble compounds that have crystallized out of solutions evaporated and cooled in the waste tanks.

Many documents have been issued describing the Hanford SSTs and SST wastes, another description will not be repeated here. The reader is referred to the following documents for information on tank dimensions, materials of construction, waste history, waste types, and past leak information:

1. RPP-13019, 2003, *Determination of Hanford Waste Tank Volumes*, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2. RPP-RPT-48221, 2010, *Data Package for Single-Shell Tank Waste Staging*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

3. WHC-MR-0132, 1990, *A History of the 200 Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

4. RPP-19822, 2005, *Hanford Defined Waste Model - Revision 5.0*, Rev. 0A, CH2M HILL Hanford Group, Inc., Richland, Washington.

5. HNF-EP-0182, 2020, *Waste Tank Summary Report for Month Ending June 30, 2020*, Rev. 390, Washington River Protection Solutions LLC, Richland, Washington.

6. HNF-4872, 1999, *Single-Shell Tank Leak History Compilation*, Rev. 0, prepared for Lockheed Martin Hanford Company, Richland, Washington, by Vista Research, Inc., Richland, Washington.

7. RPP-RPT-61279, *Single-Shell Tank Farm Leak Inventory Assessments Summary,* Washington River Protection Solutions LLC, Richland, Washington.

The Best Basis Inventory (BBI) on the Tank Waste Information Network System (TWINS), http://twinsweb.pnl.gov/twins.htm, provides regulatory accepted values for the volume and composition of waste in each tank. The Hanford SST waste volume as of July 13, 2020 is approximately 26.1 Mgal. This 26.1 Mgal excludes an additional 2.3 Mgal of retained gas and voidspace. The waste contains an estimated 88,340 MT of primary analytes (excludes water and hydroxides).

The methodology used for developing inventory values reported in the BBI is provided in RPP-7625, 2019, *Best-Basis Inventory Process Requirements*, Rev.14.

Table A-1 summarizes the BBI tank sludge, saltcake, and IL volumes by tank farm.

Table A-1. Single Shell Tank Waste Summary Information

Tank Farm	Number of Tanks	No. of Assumed Leakers	Supernate (kgal)	Sludge (kgal)	Saltcake (kgal)	% Supernate	% Sludge	% Saltcake
A	6	2	12.4	104	708	1.5	12.6	85.9
AX	4	0	21	21	420	4.6	4.5	91.0
B	12 + 4 200 series	7 + 3	30.1	1,262	630	1.6	65.6	32.8
BX	12	5	37	1,147	284	2.5	78.1	19.3
BY	12	5	0	296	3,516	0.0	7.8	92.2
C	12 + 4 200 series	2 + 4	0.2	61.9	0	0.3	99.7	0.0
S	12	1	3.4	896	2,813	0.1	24.1	75.8
SX	15	8	1.3	1,003	2,043	0.0	32.9	67.0
T	12 + 4 200 series	5 + 0	42	1,620	140	2.3	89.9	7.7
TX	18	8	2.1	771	5,030	0.0	13.3	86.7
TY	6	5	11	396	156	2.0	70.3	27.8
U	12 + 4 200 series	4 + 0	19	466	2,155	0.7	17.7	81.6

SST Waste Summary Information by Tank Farm Grouping

Tank Farm Grouping	Number of Tanks	Total Waste (kgal)	% Supernate	% Saltcake	% Sludge
A/AX	10	1,286	2.6	87.7	9.7
B/BX/BY	40	7,202	0.9	61.5	37.6
C	16	62	0.3	0.0	99.7
S/SX	27	6,759	0.1	71.8	28.1
T/TX/TY	40	8,168	0.7	65.2	34.1
U	16	2,640	0.7	81.6	17.7

Tanks classified as assumed leakers from HNF-EP-0182, *Waste Tank Summary Report for Month Ending June 30, 2020*, Washington River Protection Solutions LLC, Richland, Washington. Additional analyses and retrieval operations have indicated a number of these 58 may be sound.

A.1 REFERENCES

HNF-4872, 1999, *Single-Shell Tank Leak History Compilation*, Rev. 0, prepared for Lockheed Martin Hanford Company, Richland, Washington, by Vista Research, Inc., Richland, Washington.

HNF-EP-0182, 2020, *Waste Tank Summary Report for Month Ending June 30, 2020*, Rev. 390, Washington River Protection Solutions LLC, Richland, Washington.

RPP-7625, 2019, *Guidelines for Updating Best-Basis Inventory*, Rev. 14, Washington River Protection Solutions LLC, Richland, Washington.

RPP-13019, 2003, *Determination of Hanford Waste Tank Volumes*, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-19822, 2005, *Hanford Defined Waste Model – Revision 5.0*, Rev. 0A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-48221, 2010, *Data Package for Single-Shell Tank Waste Staging*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

Tank Waste Information Network System (TWINS), http://twinsweb.pnl.gov/twins.htm.

WHC-MR-0132, 1990, *A History of the 200 Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX B –
SINGLE-SHELL TANK WASTE PHOSPHATE, ALUMINUM AND FLUORIDE CONTENT

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Abbreviations and Acronyms

BBI	Best-Basis Inventory
HTRH	hard-to-remove heels
SST	single-shell-tank
TWINS	Tank Waste Information Network System

B.0 OVERVIEW

A number of tank constituents are known or expected to cause problems with waste retrieval. These constituents are discussed in the appendix and tables provided to enable the reader to see which tanks are of concern, and to judge the magnitude of the potential problem.

B.1 SALTCAKE

Saltcake waste has a bigger impact on double-shell tank storage space than sludge waste for two reasons. First, there is roughly twice as much saltcake as sludge, as indicated in Table A-1 of Appendix A. Second, every gallon of saltcake becomes a nominal 3 gal of supernate upon dissolution. Two saltcake-containing tanks have undergone retrieval operations to date, S-102 and S-112. Dissolution of AX-102 and S-112 proceeded in an acceptable manner until the hard-to-remove heel was met. S-102 had approximately 10 times higher phosphate concentration in the salt than S-112 and was continually plagued with slow or ineffective dissolution. High phosphate in tank saltcake has been known for years to cause transfer line plugging problems at Hanford due to waste solubility problems.

Table B-1 was prepared to indicate where phosphate salt problems may be encountered, and where saltcake retrieval should proceed without waste-caused delays. Table B-1 lists the single-shell tanks by decreasing mass of phosphate in the saltcake plus saltcake liquid. Also included are the phosphate anion mole percent concentration in the saltcake plus saltcake liquid and the volume of saltcake plus saltcake liquid in the tank. The anion mole percent is defined as 100 times the number of moles of PO_4 divided by the sum of all primary analyte anions listed in the Best Basis Inventory (BBI) (NO_2, NO_3, CO_3, PO_4, SO_4, F, Cl, C_2O_4). The pre-retrieval AX-102, S-102 and S-112 values are included for comparison purposes along with the current S-102 values. There is no remaining salt in AX-102 or S-112. The numbers, except for the pre-retrieval values for AX-102, S-102 and S-112, were calculated from a BBI data download on July 13, 2020. The calculations are shown in SSF-2404, Rev. 1 ‘Salt’ worksheet. The pre-retrieval AX-102 values were calculated from a BBI data download on April 2, 2018. The pre-retrieval S-102 values were calculated from a Best Basis Inventory data download on April 14, 2005. The pre-retrieval S-112 values were calculated from a Best Basis Inventory data download on April 16, 2003.

Table B-1 shows 17 tanks with a saltcake anion mole percent PO_4 concentration greater than the pre-retrieval concentration in S-102. Four tanks have a pre-retrieval mass of PO_4 in the salt greater than the pre-retrieval mass of PO_4 in the S-102 salt. The pre-retrieval AX-102, S-102 and S-112 tanks are highlighted.

Table B-1. Phosphate Content of Single-Shell Tank Saltcake (2 Sheets)

Tank	PO_4 (kg)	PO_4 (anion mol%)	Saltcake Volume (kgal)	Tank	PO_4 (kg)	PO_4 (anion mol%)	Saltcake Volume (kgal)
241-TX-118	189,636	29.8	233	241-T-109	121,248	58.4	84
241-BY-101	185,651	12.3	310	Pre-Retrieval S-102	106,394	6.7	384
241-TX-117	165,436	7.0	519				
241-B-105	81,970	12.6	218	241-SX-104	14,255	1.3	264
241-BY-103	77,042	5.2	384	241-A-103	14,150	1.3	376
241-TX-113	75,600	2.8	470	241-S-103	12,802	1.6	220
241-TX-114	69,700	3.5	451	241-SX-103	12,307	0.6	441
241-BY-109	67,317	8.5	266	241-TX-102	12,208	1.7	211
241-TX-112	60,283	2.4	581	241-U-111	12,071	1.8	190
241-U-107	56,162	5.7	238	241-S-107	11,250	31.4	20
241-U-109	53,388	5.1	273	241-BX-105	11,000	27.3	28
241-BY-111	53,056	4.6	344	241-BY-107	10,841	1.4	232
241-S-106	44,289	2.9	374	241-TX-103	10,296	2.0	126
241-B-109	40,848	13.4	70	241-BX-111	10,282	2.9	88
241-BX-110	38,606	6.2	141	241-B-103	10,181	11.3	36
241-B-108	35,800	16.8	60	241-TY-102	9,792	3.8	60
241-BY-102	35,692	3.7	278	241-B-102	8,591	11.4	27
241-B-107	32,926	12.7	73	241-A-101	8,536	0.9	272
241-TX-116	32,885	1.4	423	241-S-110	8,266	0.5	289
241-TX-115	32,483	1.7	447	241-S-105	8,173	0.4	382
241-S-109	32,363	1.3	473	241-AX-101	7,870	0.7	321
241-TX-105	32,057	1.8	412	241-U-106	7,781	1.5	164
241-U-103	29,891	2.7	318	241-TX-108	7,524	1.7	110
241-S-108	28,994	1.5	475	241-SX-102	7,406	0.8	287
241-TX-110	27,377	1.8	339	241-A-106	7,000	10.2	22
241-BY-105	26,650	1.2	393	241-BY-106	6,539	0.5	356
241-TX-106	25,970	1.8	349	241-SX-101	6,320	0.7	262
241-U-105	22,808	1.8	301	241-B-104	6,176	4.0	55
241-TX-111	22,681	1.8	284	241-T-108	4,587	12.7	8
241-U-108	22,499	1.5	368	241-S-101	4,266	1.7	109
241-S-111	22,369	2.5	269	241-T-101	3,235	1.7	47
241-BY-104	22,005	1.6	314	241-U-104	2,663	0.8	39
241-SX-106	20,703	2.4	267	241-B-101	2,384	1.1	75
241-TY-101	20,194	20.0	45	241-TX-104	2,141	1.8	32
Pre-Retrieval S-112	19,336	0.7	616	241-AX-103	2,115	0.8	93
				241-BX-106	1,792	2.1	26
241-SX-105	18,915	1.9	288	241-TX-107	1,668	1.3	27
241-BY-110	17,849	1.9	293				
241-TY-103	17,291	15.2	51	241-A-102	1,296	1.4	38
241-BY-108	16,039	3.6	157	Pre-Retrieval AX-102[4]	1,160	1.6	24

Table B-1. Phosphate Content of Single-Shell Tank Saltcake (2 Sheets)

Tank	PO_4 (kg)	PO_4 (anion mol%)	Saltcake Volume (kgal)	Tank	PO_4 (kg)	PO_4 (anion mol%)	Saltcake Volume (kgal)
241-BY-112	15,601	2.3	187	241-B-112	1,033	2.0	17
241-S-102	15,500	6.7	54	241-TX-101	976	1.7	14
241-U-102	14,953	1.5	264	241-S-104	41	0	149
241-SX-109	33	0	177	241-SX-111	3	0	15
241-SX-114	6	0	31	241-SX-110	2	0	10

[1] With the exception of pre-retrieval numbers for tanks AX-102, S-102 and S-112, volumes and numbers were calculated from Tank Waste Information Network System (TWINS), Queried 7/13/2020, Best Basis Inventory, http://twinsweb.pnl.gov/twins.htm

[2] Volumes and numbers calculated from Tank Waste Information Network System (TWINS), Queried 4/14/2005, Best Basis Inventory, http://twinsweb.pnl.gov/twins.htm

[3] Volumes and numbers calculated from Tank Waste Information Network System (TWINS), Queried 4/16/2003, Best Basis Inventory, http://twinsweb.pnl.gov/twins.htm

[4] Volumes and numbers calculated from Tank Waste Information Network System (TWINS), Queried 1/16/2017, Best Basis Inventory, http://twinsweb.pnl.gov/twins.htm

B.2 SLUDGE

Retrieval of sludge to date has been impacted by hard-to-remove heels (HTRH) which have occurred in all predominantly sludge tanks that have undergone retrieval. The HTRH problems have been largely due to agglomerated waste that is too large to pass through the pump suction screens or that pass through the screen and is too large to lift into the pump. In most tanks some of the agglomerated waste chunks have been too large to be mobilized with the sluicing stream, and in C-111 essentially all the waste in the tank was too monolithic to be mobilized. Sampling of waste sludge heels to date has shown the two primary constituents are aluminum hydroxide and sodium fluoride phosphate.

Aluminum hydroxide, $Al(OH)_3$, is a major constituent in most tanks with sludge. When the compound was added to the waste tank it was as a fine precipitate. Over years in storage the aluminum hydroxide has formed the mineral gibbsite, which consists of interlocked molecules of $Al(OH)_3$. It is likely that other solid forms such as boehmite (AlO(OH)) and sodium fluoride phosphate, $Na_7F(PO_4)_2 \bullet 19H_2O$ are also present. Boehmite is refractory and not amenable to caustic dissolution at low temperatures. Sodium fluoride phosphate is a salt with a low solubility in water, and insoluble in the high sodium concentrations found in single-shell tank (SST) liquids. The $Na_7F(PO_4)_2 \bullet 19H_2O$ has formed crystals that are too big to enter the pump screen.

Tables B-2 and B-3 were prepared to indicate where sludge sodium fluoride phosphate and aluminum hydroxide problems may be encountered. Table B-2 lists the single-shell tanks by decreasing theoretical maximum of $Na_7F(PO_4)_2 \bullet 19H_2O$ which could be present. The latter is more informative than separate fluoride and phosphate numbers since the mass is dependent upon the stoichiometric ratio of phosphate to fluoride. Table B-3 lists the single-shell tanks by decreasing theoretical maximum mass of $Al(OH)_3$. Although the data is not repeated in this appendix, RPP-RPT-47306, *Waste Type Analysis for Aluminum Leachability Estimates of All Non-Retrieved Hanford Tank Wastes*, lists the mass of caustic leachable aluminum. The amount of soluble or leachable aluminum with the total theoretical mass of $Al(OH)_3$ is used to determine whether or not chemical dissolution will be used as a hard to remove heel retrieval technology. Tanks which have had retrieval operations performed are highlighted in yellow, with the values shown calculated from the pre-retrieval TWINS data referenced at the bottom of the table.

The numbers for non-highlighted tanks were calculated from a Best Basis Inventory data download on July 13, 2020. The maximum theoretical mass of $Al(OH)_3$ was calculated by assuming all the Al in the sludge formed $Al(OH)_3$. The maximum theoretical mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ was calculated by determining which constituent (PO_4 or F) was the limiting factor and calculating the $Na_7F(PO_4)_2 \bullet 19H_2O$ mass based upon that constituent assuming there was sufficient excess sodium present.

Although the $Na_7F(PO_4)_2 \bullet 19H_2O$ present likely formed from sodium, fluoride, and phosphate molecules that were in solution, only the masses shown by TWINS as present in the sludge are provided in Table B-2. This is because it is assumed that $Na_7F(PO_4)_2 \bullet 19H_2O$ in the salt phase in a tank will be dissolved by the water used for saltcake dissolution, so only the sludge $Na_7F(PO_4)_2 \bullet 19H_2O$ will likely be a concern.

Table B-2. Sodium Fluoride Phosphate Content of Single-Shell Tank Sludge[1]

Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)
TX-109	509,643	BX-108	42,907	C-106[7]	10,155	T-203	4,572
BX-107	487,158	B-108	42,720	TX-104	11,429	SX-102	4,422
T-104	415,958	BY-101	42,720	BX-109	10,830	T-103	4,223
T-111	242,080	TY-101	42,720	T-108	10,043	BY-109	4,197
C-110[2]	228,589	TY-104	42,683	T-105	9,058	S-101	3,935
T-107	222,968	BX-111	42,345	SX-105	7,502	B-112	3,860
C-107[3]	218,846	BY-110	41,221	B-201	7,270	U-202	3,860
BX-112	178,749	BY-108	39,347	T-201	7,157	BY-105	3,819
B-104	163,011	TY-105	38,973	BX-106	6,786	SX-112	3,616
B-107	134,047	C-111[5]	34,753	BY-107	6,708	TX-101	3,549
B-109	128,909	TY-103	33,989	SX-103	6,708	SX-104	3,485
TX-113	124,038	BY-106	32,377	C-103[4]	6,667	T-112	3,418
U-110	97,183	B-105	26,906	SX-101	6,558	SX-109	3,365
B-106	96,083	C-101[2]	25,782	U-203	6,520	S-111	3,350
BX-110	89,150	BX-102	25,763	SX-114	6,423	S-110	2,713
B-110	86,879	BY-104	24,545	B-204	5,696	SX-110	2,466
T-110	78,283	C-109[4]	24,227	TX-114	5,584	TX-116	2,398
U-112	63,181	C-105[6]	22,525	U-107	5,509	U-102	2,185
C-102[2]	61,314	U-111	19,546	B-203	5,471	T-202	2,170
TX-111	60,707	T-106	17,107	B-202	5,321	BX-101	1,866
B-111	60,295	S-102	15,139	BX-105	5,048	U-105	1,581
C-108[4]	57,709	BX-104	14,038	T-204	4,984	TX-115	1,297
TX-110	52,088	BX-103	13,191	SX-111	4,943	BY-103	1,267
C-112[2]	44,793	C-104[3]	11,943	SX-107	4,890	TX-117	1,064
S-107	44,343	U-103	11,542	U-201	4,759	U-101	959

Table B-2. Sodium Fluoride Phosphate Content of Single-Shell Tank Sludge[1]

Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)	Tank	Max Theoretical Mass of $Na_7F(PO_4)_2 \bullet 19H_2O$ (kg)
U-104	933	S-103	457	A-105	126	AX-101	0
U-109	731	S-108	254	AX-104	123	AX-102	0
T-102	686	SX-115	234	S-105	107	B-101	0
SX-108	678	TY-106	232	SX-113	107	B-103	0
S-109	656	S-104	225	A-101	52	BY-112	0
TX-108	648	A-106	213	A-103	38	T-101	0
S-112[8]	558	TX-106	201	A-102	24	TX-102	0
A-104	522	AX-103	142	U-204	20	TX-105	0

[1] With the exception of pre-retrieval numbers for the C-100 series tanks and S-112, numbers were calculated from Tank Waste Information Network System (TWINS), Queried 7/13/2020, https://twins.pnl.gov/twinsdata/Forms/About.aspx

[2] C-101, C-102, C-110, C-112 – BBI data for 3rd quarter 2008 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 8/4/08

[3] C-107 – Tank Waste Information Network System (TWINS), Queried for BBI waste volumes 7/25/11 at https://twins.pnl.gov/twinsdata/Forms/About.aspx

[4] C-103, C-108, and C-109 – BBI data for 3rd quarter 2004 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 7/28/04

[5] C-104, C-111 – BBI data for 1st quarter 2010 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 1/4/10

[6] C-105 – Tank Waste Information Network System (TWINS), Queried for BBI waste volumes 10/1/16 at https://twins.pnl.gov/twinsdata/Forms/About.aspx

[7] C-106 – Data are pre-1999 retrieval from Table F4-1 in WHC-SD-WM-ER-615, 1998, *Tank Characterization Report for Single-Shell Tank 241-C-106*, Rev 0B, Place, D. E., Cogema Engineering, Inc. for Lockheed Martin Hanford Company, Richland, Washington.

[8] S-112 – BBI data for 2nd quarter 2003 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 4/16/03

Table B-3. Aluminum Hydroxide Content of Single-Shell Tank Sludge[1]

Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)
S-107	1,055,022	C-107	168,133	T-105	67,886	BX-110	20,806
C-102[2]	802,132	SX-105	162,933	C-109[4]	67,398	BY-101	20,800
U-110	528,378	SX-101	159,178	T-101	63,849	TX-113	20,569
S-101	491,111	BX-101	113,244	B-107	58,847	BY-105	19,904
SX-114	457,022	U-112	108,016	C-108[4]	54,542	S-108	18,171
C-105[3]	448,179	TX-104	105,752	U-108	49,978	BY-108	17,276
SX-111	353,022	B-109	104,867	U-111	49,804	BY-106	17,044
SX-107	348,978	C-106[6]	104,000	S-109	46,800	BX-111	7,020
C-103[4]	305,644	T-107	102,556	BY-104	46,222	T-110	6,826
S-110	297,556	TX-109	101,256	T-106	45,327	U-204	6,558
S-104	288,889	BY-109	98,222	C-110[2]	40,733	TY-104	6,484
C-104[5]	258,729	U-105	91,578	C-112[2]	34,008	BX-109	6,240
SX-112	258,267	C-111[5]	90,422	S-103	33,014	A-101	6,211
TX-101	254,214	U-109	80,600	TY-101	28,398	TY-105	5,980
SX-104	248,733	BX-102	79,358	BX-112	28,022	TY-103	5,385
SX-109	240,067	BX-107	75,978	BY-103	27,387	BX-108	5,177
S-111	239,200	T-103	74,244	U-103	26,751	AX-104	4,940
BX-104	229,757	S-102	72,511	SX-102	26,433	AX-103	4,420
C-101[2]	229,436	B-108	71,356	BY-110	26,376	B-110	3,978
U-102	156,000	T-104	71,067	BX-105	25,104	T-112	3,970
BX-103	136,425	U-107	70,778	TX-116	23,949	U-203	3,960
SX-108	180,844	T-102	69,044	A-104	23,065	B-105	3,218
SX-110	175,933	U-101	68,467	A-106	20,887	B-111	2,798

Table B-3. Aluminum Hydroxide Content of Single-Shell Tank Sludge[1]

Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)	Tank	Max Theoretical Mass of $Al(OH)_3$ (kg)

[1] With the exception of pre-retrieval numbers for the C-100 series tanks, numbers were calculated from Tank Waste Information Network System (TWINS), Queried 7/13/2020, https://twins.pnl.gov/twinsdata/Forms/About.aspx

[2] C-101, C-102, C-110, C-112 – BBI data for 3rd quarter 2008 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 8/4/08

[3] C-105 – Tank Waste Information Network System (TWINS), Queried for BBI waste volumes 10/1/16 at https://twins.pnl.gov/twinsdata/Forms/About.aspx

[4] C-103, C-108, and C-109 – BBI data for 3rd quarter 2004 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 7/28/04

[5] C-104, C-111 – BBI data for 1st quarter 2010 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 1/4/10

[6] C-106 – Data are pre-1999 retrieval from Table F4-1 in WHC-SD-WM-ER-615, 1998, *Tank Characterization Report for Single-Shell Tank 241-C-106*, Rev 0B, Place, D. E., Cogema Engineering, Inc. for Lockheed Martin Hanford Company, Richland, Washington.

[3] C-107 – Tank Waste Information Network System (TWINS), Queried for BBI waste volumes 7/25/11 at https://twins.pnl.gov/twinsdata/Forms/About.aspx

[8] S-112 – BBI data for 2nd quarter 2003 obtained from Tank Waste Inventory and Characterization Group files on 1/12/11, file date 4/16/03

B.3 REFERENCES

See bottom of tables for data sources.

RPP-RPT-47306, 2013, *Waste Type Analysis for Aluminum Leachability Estimates of All Non-Retrieved Hanford Tank Wastes,* Rev 1, Washington River Protection Solutions LLC, Richland, Washington.

APPENDIX C – DESCRIPTION OF WASTE RETRIEVAL PROCESSES

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LIST OF TERMS

Abbreviations and Acronyms

ALC	air lift circulator
CTF	Cold Test Facility
DST	double-shell tank
Ecology	Washington State Department of Ecology
ERSS	extended reach sluicing system
HFFACO	Hanford Federal Facility Agreement and Consent Order
HTRH	hard-to-remove heel
ITV	in-tank vehicle
MARS	mobile arm retrieval system
MARS-S	mobile arm retrieval sluicing system
MARS-V	mobile arm retrieval vacuum system
MRS	mobile retrieval system
RWL	Remote Water Lance
SST	single-shell-tank
VR-200	vacuum retrieval in 200 series tanks
WTP	Waste Treatment and Immobilization Plan

C.0 INTRODUCTION

This appendix describes waste retrieval processes that have either been used for waste retrieval in single-shell tanks (SSTs) at Hanford or have been evaluated to the point where it is believed the process is viable.

C.1 RETRIEVAL PROCESSES

C.1.1 MODIFIED SLUICING WITH EXTENDED REACH

Modified sluicing with standard sluicers has been phased out for extended reach sluicing, which uses a sluicing arm with an elbow and extendable boom, this system is called an extended reach sluicing system (ERSS). The ERSS can move the sluice nozzle in close proximity to the waste for a more effective sluicing than the standard sluicers. The ERSS boom is designed to extend and retract with a range of 15 to 28 ft and elevate approximately 90° along the vertical. The mast rotates ±180°, providing a side-to-side motion to the boom. These operations can be manipulated to bring the nozzle much closer to the waste in the tank than is possible with the fixed-elevation standard sluicer. The nozzle on the ERSS is capable of continuous rotation 360° in both the elevation and transverse functions. The ERSS also includes the capability to use high pressure water spray.

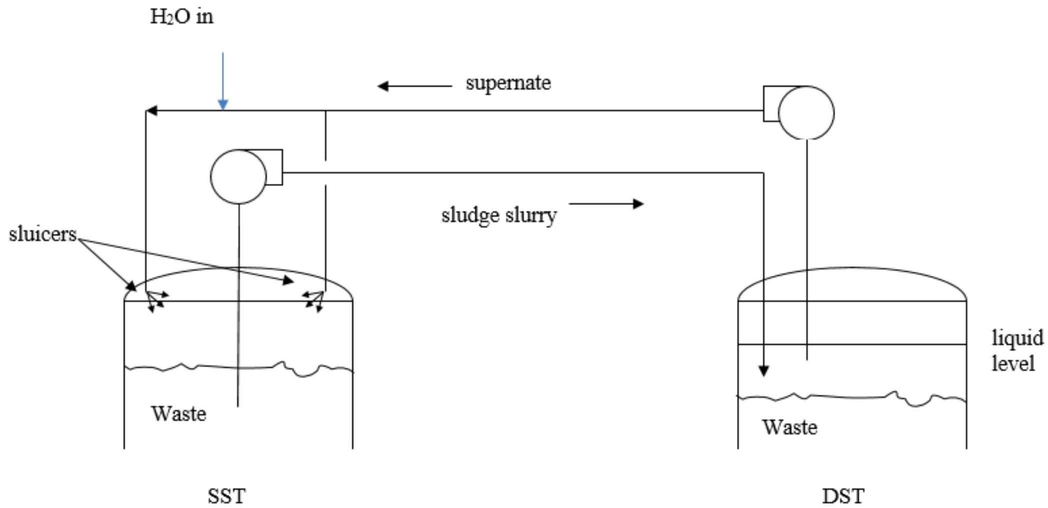
C.1.1.1 Extended Reach Sluicing System – Sludge Removal with Double-Shell Tank Supernate

ERSS with double-shell tank (DST) supernate is used primarily to retrieve sludge. It consists of directing a stream of supernate onto the SST sludge to mobilize the waste into a slurry and direct the slurry to the inlet of a pump. The pump transfers the slurry to a receiving tank where sludge settles out and the liquid is returned to the SST for reuse. If saltcake is present in an SST, some of it will also dissolve in the supernate and be removed. Figure C-1 is a schematic of the process.

Supernate is liquid in the receiver tank consisting of water and dissolved salts. The supernate is pumped from the receiver tank to the SST in shielded transfer lines, and enters the SST via sluice nozzles.

Supernate is normally used for sluicing instead of water because it minimizes the addition of liquid to the DST system that would take up space or have to be evaporated. The ERSS is equipped with high pressure water nozzles that can be used to break up hard agglomerations of waste. The high pressure water is only used as needed to minimize additions to the DST system. Modified sluicing with standard sluicing and supernate has been used for bulk waste retrieval in C-106, C-103, C-104, C-108, C-109, C-110, C-111 and C-112. ERSS with supernate has been used for bulk waste retrieval in C-101, C-102, and for hard-to-remove heel (HTRH) retrieval in C-105.

Figure C-1. Simplified Schematic of General Modified Sluicing Sludge Removal Process Using DST Supernate



C.1.1.2 Extended Reach Sluicing System – Sludge Removal with Water

ERSS with water is performed in a manner similar to ERSS with supernate, except that water is used instead and no DST pump is required. The advantage of using water is no receiver tank pump is required, nor are shielded transfer lines to the SST and shielded sluicer equipment unless the water/waste is recirculated. The disadvantage is the volume of liquid added to the DST system that will require storage or evaporation. ERSS with water might be used primarily for a tank containing a large volume of saltcake. Modified sluicing with water was used for part of the waste heel retrieval operations in S-112.

C.1.1.3 Extended Reach Sluicing System – Saltcake Dissolution

Saltcake dissolution is a form of modified or extended reach sluicing with water. The main differences are that the solution will normally have a longer residence time in the SST than the supernate or water used in sludge sluicing, and salt solids dissolve into solution for transfer out of the SST rather than remaining insoluble and being sluiced out of a tank as in sludge sluicing. Residence time is needed for effective dissolution of the salt. Dissolution rate is a function of the saltcake composition, the quantity of salt surface area exposed to the liquid, the concentration of salts in the liquid, and the liquid temperature. During saltcake dissolution with water, a DST pump and supernate transfer lines from the DST to the SST are not used.

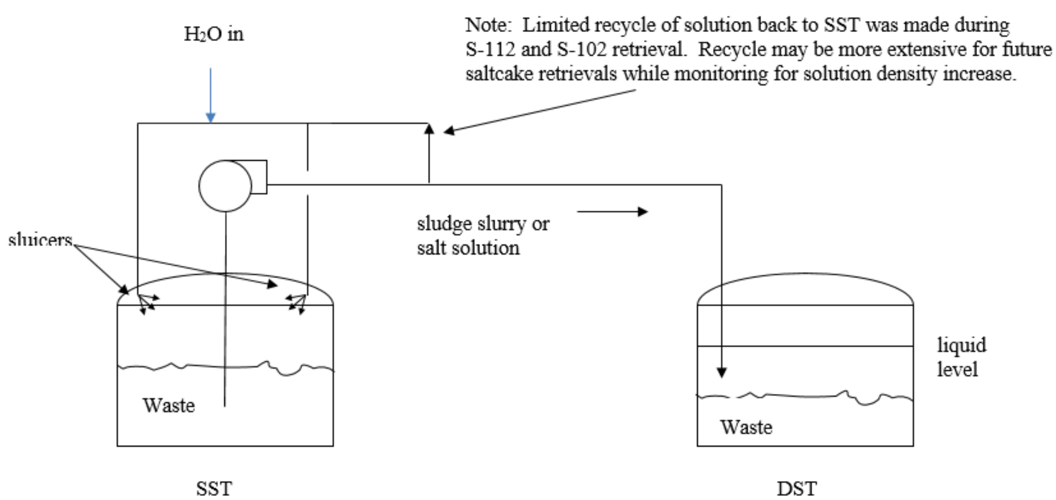
Saltcake dissolution has been used for waste retrieval in AX-102, S-102, S-112, and during a limited test in U-107. For S-102 and S-112, water was added to the tank and allowed to sit for a period before being pumped out. In U-107 the water was sprayed on the waste surface and the solution was pumped out semi-continuously with a low-flow-rate pump after the liquid percolated through the salt to a central screen in the tank. In AX-102 water was added then recirculated.

Saltcake dissolution in S-102 and S-112 was performed using a relatively high rate of water addition in concert with periodic pump-out of the salt solution. Future saltcake tanks will likely continue like AX-102: add water, recirculate the solution continuously out of the SST and back to the tank via the sluicers to dissolve the salt, and then pump the solution to the DST when the concentration in the salt slurry begins to level off.

Another alternative would be to add water continuously at a low rate while continually pumping out at a low rate (similar to the process used in U-107). Such a process could have problems with particles settling in the transfer line to the DST due to low velocity and is not recommended until such problems can be resolved.

Figure C-2 is a schematic of the process.

Figure C-2. Simplified Schematic of General Modified Sluicing Saltcake Dissolution Processes Using Water



C.1.1.4 Sluicing-Saltcake Dissolution with Added Phosphate Removal Equipment

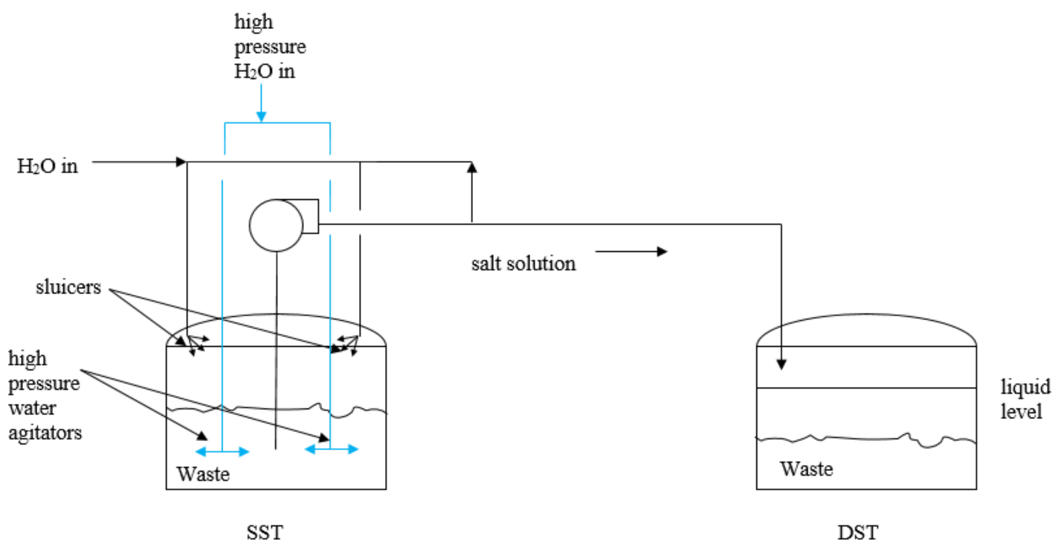
The modified sluicing equipment used in S-112 was satisfactory for saltcake retrieval until the HTRH was met. This tank had a pre-retrieval saltcake phosphate concentration of 0.67 anion mole % per Appendix B. The modified sluicing equipment installed in S-102 was similar to that in S-112 but was initially ineffective in removing the saltcake due to the high PO_4 concentration of 6.7 anion mole %, or ten times that of S-112. S-102 retrieval was improved after several high pressure water agitators were developed and added to the tank. These mixers used nominal 30,000 psi water and rotated to break up the salt to increase the surface area for dissolution. The agitators each created about a 15-20 ft diameter cylinder in the salt. Sluicing was halted before it was determined whether the agitators would have been effective in completing retrieval in the tank.

It is unknown at what phosphate concentration additional equipment must be added to a tank with high PO_4 salt to mobilize it effectively for dissolution, but RPP-40545, *Quantitative*

Assumptions for Single-Shell Tank Waste Retrieval Planning, Rev. 6, estimates that modified sluicing salt dissolution rates could be adequate for PO_4 concentrations up to two times the concentration in S-112, and that PO_4 concentrations up to three times the concentration in S-112 could be accommodated, albeit at a reduced retrieval rate, before additional salt mobilization equipment was required. Three times 0.67 anion mole % is 2.0 anion mole %. Therefore, a saltcake PO_4 concentration of 2.0 anion mole % is suggested as a point where equipment should be considered for addition to a tank to augment phosphate removal, depending upon the volume of salt in the tank. Table B-1 in Appendix B lists the saltcake PO_4 concentration in each tank. There are 39 tanks with a saltcake PO_4 concentration of 2.0 anion mole % or higher (17 tanks with a concentration at or above that of S-102). These 39 tanks are marked with a footnote in Table 6-1 in the main body of this document. 26 of these 39 tanks are shown in Table 6-1 as using ERSS for waste retrieval. It is assumed that an ERSS with HPW capability will minimize the need for additional phosphate removal equipment especially when an in-tank vehicle is planned for the hard-to remove heel (HTRH) retrieval technology.

Figure C-3 is a schematic of the assumed process. This figure shows high pressure water agitators used similar to those in S-102, but the mobilization method eventually used could be different.

Figure C-3. Simplified Schematic of General Modified Sluicing High Phosphate Saltcake Dissolution Process



C.1.2 MOBILE ARM RETRIEVAL SLUICING SYSTEM

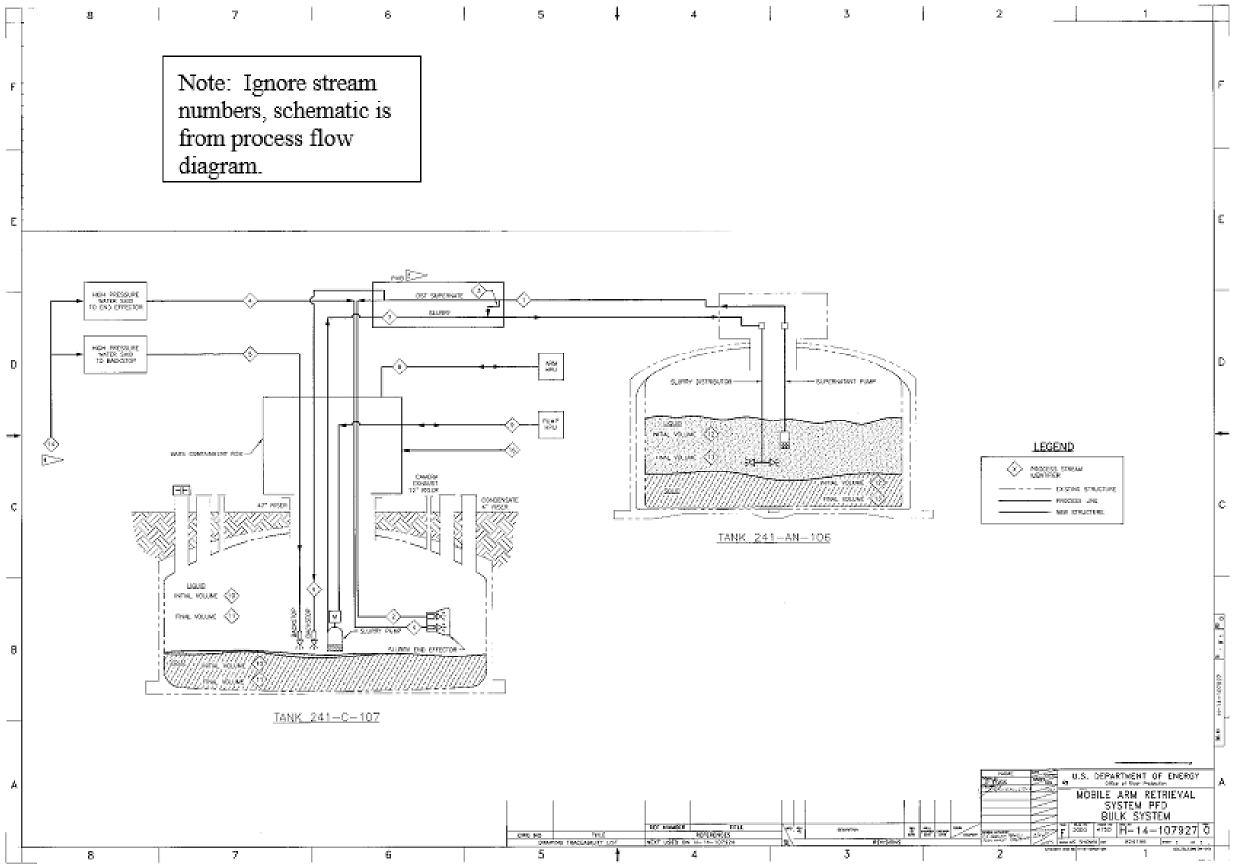
The mobile arm retrieval sluicing system (MARS-S) is a robotic arm used to retrieve tank waste. The MARS-S could be deployed in any tank with a central 42-in. access riser unless interference with in-tank obstructions prevent its use. The MARS-S is not currently planned to be used on future tanks due to complexity of design.

The arm is designed to reach all areas of the tank unless access is blocked by an obstruction such as an air lift circulator (ALC). The MARS-S sits on a support platform around the large central tank riser. A turntable above the platform supports a mast that extends down into the tank. The mast supports a carriage and hydraulically operated mechanical arm. The arm, which has an elbow and three telescoping segments, is attached to the carriage that moves up and down on the mast only when the arm is being installed or removed. The carriage is otherwise fixed during retrieval operation. The turntable rotates to position the arm radially within the tank. The arm supports a wrist with pan and tilt capabilities, and houses low-pressure supernate sluicing and high-pressure water nozzles attached to the wrist.

The combined motion of these components is expected to allow access to all waste-containing areas of the tank. A ‘strongback’ for support is deployed alongside the mast/arm within the riser and serves to support the in-tank hose management system and reel. The waste slurry pump is installed down the center of the mast. The nozzles on the arm are used to mobilize waste and direct it towards the pump suction.

The MARS-S went through an integrated demonstration test on three waste simulant mixtures in September of 2009 at the Cold Test Facility (CTF). The results of this test are provided in RPP-RPT-43107, *MARS Technology Phase II Qualification Test Report.* The unit demonstrated an effective capability for waste retrieval. The MARS-S was able to reach and clean the tank wall, and the wrist movement allowed the sluicing action to reach around items. The arm elbow joint movement, arm “in and out” movement, wrist multi-axis movement, and the rotational movement of the mast/carriage/arm/pump all worked smoothly together. The ability to hydraulically “rake” material from the outer reaches of the tank into the influence of the pump was demonstrated and is a capability that is not available with modified sluicing. To improve heel retrieval, a pump ‘backstop’ is also installed. The MARS-S began operation in C-107 on September 27, 2011. Retrieval of tank C-107 was declared completed to the limit of technology on August 7, 2014, with an average estimate of 1,368 ft3 of waste remaining in the tank (RPP-RPT-58514, *Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment*).It was believed that the MARS-S would permit achievement of equal or lower residual waste volumes than those achieved with modified sluicing or saltcake dissolution. However, waste solids in tank C-107 became agglomerated with phosphate salt crystallization during the process and could not be further retrieved. As of July 2020, MARS-S is not planned to be used in any future tanks because ERSS has much of the same capability and can be more easily deployed provided tank pits can be adequately refurbished. Figure C-4 is a schematic for the MARS-S process taken from the process flow diagram for C-107.

Figure C-4. Schematic of Mobile Arm Retrieval Sluicing System Process for Sludge or Saltcake



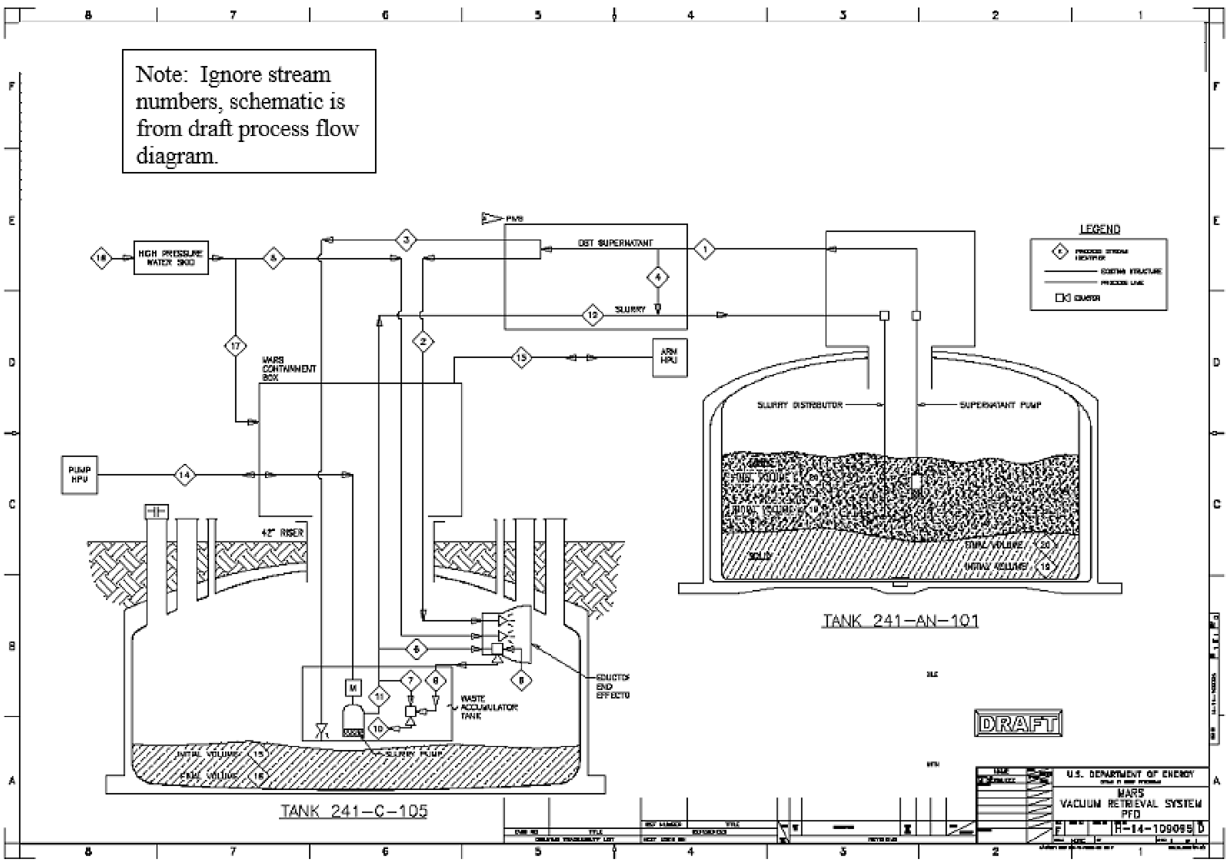
C.1.5 MOBILE ARM RETRIEVAL VACUUM SYSTEM

The Mobile Arm Retrieval Vacuum System (MARS-V) is similar to the MARS-S but is designed for use in tanks assumed to be leaking. The MARS-V is the same basic arrangement as the MARS-S above grade, but the MARS-V head is redesigned to include a suction nozzle as well as the supernate/water sluicing nozzles. Supernate and water are used to mobilize the waste, which is then sucked up with the suction nozzle on the head rather than being directed back to a central pump. The waste slurry from the suction nozzle is discharged into a small central tank mounted on the mast carriage inside the head space of the SST. The slurry pump that transfers the waste to the DST is located inside the small central tank.

Vacuum for the MARS-V is provided by an eductor system. The motive fluid for the eductors is waste solution in the small central tank, with the slurry pump directing some of the waste solution back to the DST and the rest of the solution through the eductors. Integrated system testing of the MARS-V system was performed in 2011. The MARS-V began operation in tank C-105 on June 11, 2014 and completed November 11, 2015 with the failure of the educator supply hose on the end effector. A more complete description of the MARS-V for assumed leaking SSTs is provided in RPP-RPT-50506, *MARS-V Technology Qualification Test Report*, Rev. 0.

Figure C-5 is a schematic of the process taken from the draft process flow diagram for C-105.

Figure C-5. Schematic of Mobile Arm Retrieval Vacuum System Process for Sludge or Saltcake



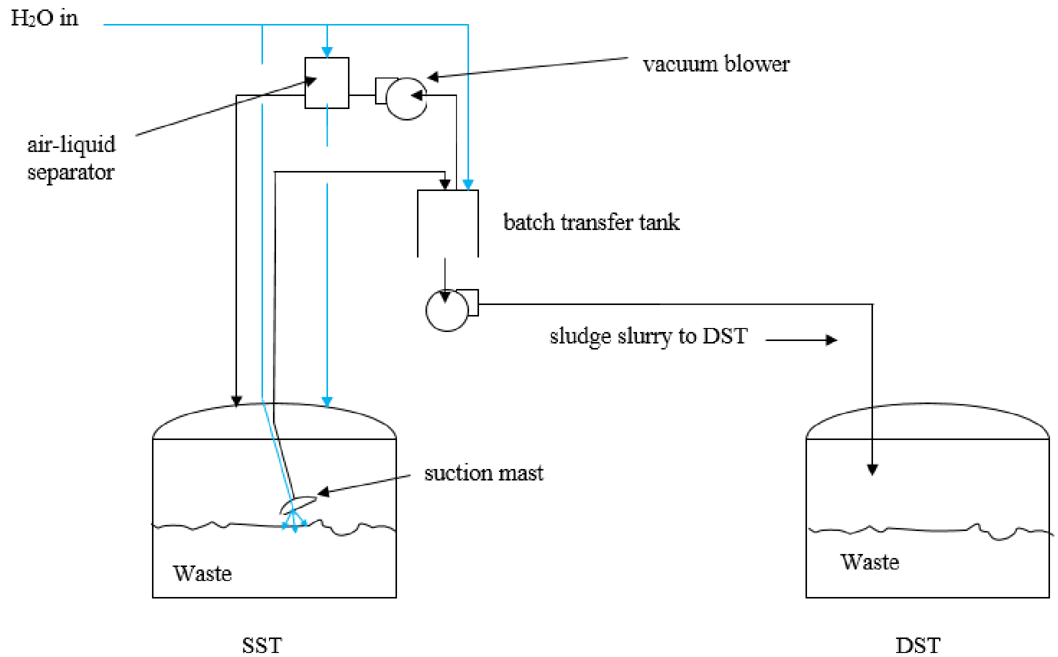
C.1.6 VACUUM RETRIEVAL IN 200 SERIES TANKS (VR-200)

The VR-200 process was used for waste retrieval in C-201, C-202, C-203, and C-204. The process used a mast arm capable of in-and-out, back-and-forth, and rotational motion. This arm was inserted into a riser around the perimeter of these tanks and used to vacuum up the waste through a suction head covered with a protective screen. The vacuum head was equipped with low- and high-pressure water sprays. Vacuum was provided from an above ground skid equipped with vacuum blowers. Vacuum was drawn on a 200-gal batch tank in another skid, which in turn pulled vacuum on the mast. When the batch tank was full, the vacuum system was stopped and the batch tank pumped out to the receiving DST.

Using this process, waste was removed from the C-200 tanks to below the Hanford Federal Facility Agreement and Consent Order (HFFACO) (Ecology et al. 1989) limits, but the retrieval rates were very low. This is believed to have been caused by the small screen size in the mast head that restricted flow of waste particles into the mast and/or resulted from the length of the vacuum line to the mast head. Operation was also restricted by inadequate cooling for the liquid recirculated through the vacuum blowers. The equipment was more complex and demanding of resources than modified sluicing or saltcake dissolution. Vacuum retrieval is planned for use on 200 series tanks that are known or assumed leakers. The only assumed leaking 200 series tanks are three of the four B-200 tanks. The VR-200 system is planned for use on all four B-200 tanks because it should be more efficient than installing a parallel sluicing system for the fourth (sound) tank.

Figure C-6 is a schematic of the VR-200 process.

Figure C-6. Simplified Schematic of Vacuum Retrieval Process for 200-Series Tanks

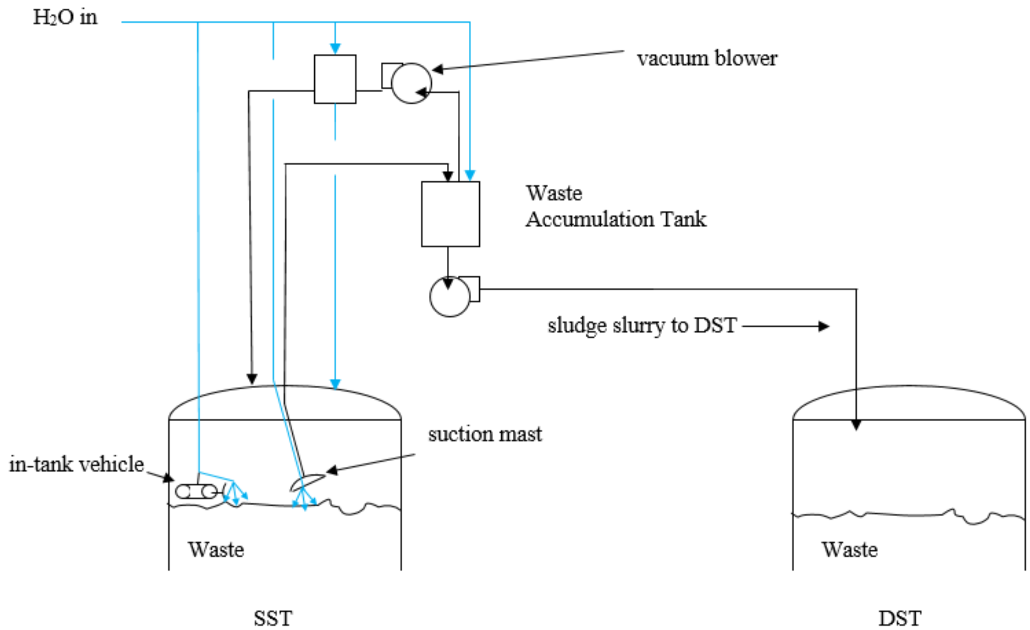


C.1.7 MOBILE RETRIEVAL SYSTEM (VACUUM RETRIEVAL WITH IN-TANK VEHICLE) FOR 100 SERIES TANKS

The Mobile Retrieval System (MRS) is the vacuum retrieval system with an in-tank tracked vehicle used to push or spray waste to the vacuum head inlet. The in-tank vehicle (ITV) is required since the vacuum head has a reach radius of about 20 ft around the center of the 37.5-ft radius 100 series tanks. The system has a 400-gal batch tank, with the rest of the equipment similar to the VR-200 design. The MRS has not been deployed in any tanks to date. The MRS equipment was purchased and tested both at the manufacturer’s facilities and at the CTF in 2002-2003.

Figure C-7 is a schematic of the process.

Figure C-7. Simplified Schematic of Mobile Retrieval System (Vacuum Retrieval with In-Tank Vehicle) for 100-Series Tanks



C.1.8 ADDITIONAL RETRIEVAL TECHNOLOGIES

These are the technologies currently planned or under evaluation for use in SST retrieval operations. Numerous retrieval technologies have been evaluated over the years for use in Hanford SSTs (e.g., see WHC-EP-0352, *Single-Shell Tank Waste Retrieval Study*). Alternatives for improvement have been suggested for the current modified sluicing and saltcake dissolution processes.

C.2 HARD-TO-REMOVE HEEL (HTRH) RETRIEVAL PROCESSES

The term 'hard-to-remove heel retrieval' refers to retrieval of waste remaining when the installed retrieval process is no longer effective. A hard-to-remove heel has been encountered to date in all tanks in which retrieval has progressed to near the tank bottom. A hard-to-remove heel could come in several forms. In S-112, a smooth, hard, saltcake layer was encountered when the waste was reduced to 25 – 30 kgal. The monolithic layer significantly slowed dissolution but was eventually broken up with an ITV equipped with a high-pressure water spray wand. In all of the C-Farm sludge tanks, a HTRH was encountered toward the end of retrieval that consisted primarily of aluminum hydroxide or sodium fluoride phosphate waste with particle size too large to be suspended or drawn into the pump screen, and/or which ended up being pushed around the tank with the sluicers rather than being drawn into the pump. The HTRH volume could also increase if a tank contained a large quantity of failed equipment or other solid objects on the tank bottom.

The method of heel retrieval for a specific tank is dependent upon the conditions encountered during retrieval and can't be predicted in advance. As of July 2020, the following HTRH retrieval operations have been attempted or completed in SST retrieval operations:

- Modified sluicing oxalic acid dissolution (C-106)
- Modified sluicing 8M NaOH heel soak (S-112)
- Modified sluicing 50% solution NaOH dissolution of $Al(OH)_3$ in tanks C-104, C-108, and C-109, and C-112
- Modified sluicing with water and ITV – (S-112)
- Modified sluicing with supernate and ITV – (C-109 and C-110)
- Repeated low concentration sludge sluicing (C-103)
- Repeated low concentration vacuum retrieval (all 4 C-200 tanks)
- ERSS with high pressure water (C-101 and C-102)
- ERSS with 50% NaOH Dissolution of $Al(OH)_3$ in tanks C-111 and dissolution of $NaAlCO_3(OH)_2$ in C-105.

The following HTRH retrieval operations have been tested at the CTF:

- Foldtrack®ITV (prior to use in C-109 and C-110)
- Large ITV used for the MRS
- Remote Water Lance (RWL), also referred to as 'Salt Mantis' (prior to use in S-112)
- 'Sand Mantis', an improved version of 'Salt Mantis' that can vacuum up waste solids and discharge them to a pump inlet
- Several additional vehicles of varying designs that performed similar to the 'Salt Mantis'.

The following HTRH retrieval operations have been performed at the Savannah River Site:

- 'Sand Mantis' with in-tank grinder

In addition, the following have been tested at the CTF and installed and operated successfully to help break up high phosphate saltcake in S-102:

- Rotating high pressure water mixers

For SST retrieval planning, HTRH retrieval is assumed to consist of one of the following methods:

1. General ITV for sludge or saltcake removal
2. Chemical dissolution:
   a. Water dissolution for $Na_7F(PO_4)_2 \bullet 19H_2O$ removal
   b. 50% NaOH solution soak to break down $Al(OH)_3$ to $NaAlO_2$, then dissolving the latter with water sluicing it out of the tank.
   c. Oxalic acid dissolution of metal oxide sludge.

No specific ITV is assumed deployed, only a generic vehicle with a high pressure water spray that moves around the tank, breaks up the waste, helps dissolve it or mobilize the particles, and moves the solution or particles to a pump or jet for removal.

Methods used or planned for removal of hard-to-retrieve waste heels are described in the following subsections.

C.2.1. CONTINUATION OF BULK RETRIEVAL PROCESS

For some tanks, such as C-103 and the C-200 tanks, the existing modified sluicing and vacuum retrieval processes were continued with no additional tools at significantly lower retrieval rates during heel removal until retrieval completion. For the MARS-S, MARS-V, VR-200, and MRS processes, it is assumed the equipment will retrieve waste to below the HFFACO residual volume limit. For ERSS retrieval proceeding with the same method is unviable as it has already reached its limit.

C.2.2 HARD-TO-REMOVE HEEL RETRIEVAL WITH ADDITIONAL IN-TANK VEHICLE

An ITV equipped with a high-pressure spray wand was used with good results to break up and help dissolve the hard saltcake heel in S-112. An in-tank tracked vehicle equipped with a pushing blade and a high-pressure wand was used with mixed results on the C-109 heel consisting of various sized sludge clods. The vehicle appeared to operate successfully for several hours before one of the tracks came off. It was operated with this limited mobility for a few more days until hydraulic failure caused operations to cease. Observation with a video camera seemed to show the tracked vehicle mobilizing waste, but material balance data showed no measurable recovery in the short time the tracked vehicle operated.C-110 also had an ITV that was deployed to help move solids from the edge of the tank closer to the sluicers and pump. The vehicle operated for a period of time until a hydraulic leak was discovered in the ITV umbilical cord when moving the left track in forward and when moving the right track in reverse. As a result, the ITV was parked near the slurry pump and continued to be used to supply high pressure hot water as a backstop to solids sluice to the pump and help to suspend and dissolve solids particles.

Several other high-pressure water-equipped ITV designs have gone through cold testing at CTF but have not been placed into a tank to attempt heel removals.

C.2.3 CHEMICAL DISSOLUTION

Two chemicals have been used since 2003 for heel dissolution: oxalic acid and sodium hydroxide. Inhibited sulfuric acid was used to aid the A-105 hard heel dissolution in the 1970s.

Approximately 142 kgal of 1M oxalic acid was added to C-106 in six batches in 2003. The acid, combined with water sluicing following each batch, appears to have mobilized and removed an estimated 15 kgal of the metal oxides in the hard sludge heel.

For S-112, approximately 13 kgal of 8M NaOH was added to the heel to attempt to break down some of the aluminum hydroxide agglomerated solids in the heel. The caustic appeared to turn the waste into much finer particles, i.e., some of the bonds holding the material together were broken, but material balance data were inconclusive as to whether any overall improvement was achieved with waste retrieval. A later evaluation of lab data (internal letter 74A10-WSC-08-152, *Results of Testing Performed to Characterize Tank S-112 Heel Solids*) indicated that dissolution of S-112 heel samples with 19M NaOH showed close to nine times the dissolution quantity after eight days as occurred with 8 M NaOH. This indicates that 19M NaOH sludge heel washing should be much more effective than an 8 M NaOH wash.

Prior to C-105 hard heel retrieval sampling and analysis were done to the remaining waste. The results showed the major solid phases to be dawsonite, trona, cejkaite, and an unidentified organic solid, with minor amounts of gibbsite, natrophosphate, and traces of unidentified iron-rich and manganese-rich phases. Approximately 30 kgal of 19M NaOH was added to the tank in attempt to break down the aluminum solids.

Samples of the sludge heel in C-108 obtained in the summer of 2009 showed the presence of significant levels of insoluble aluminum hydroxide, $Al(OH)_3$, and sodium fluoridephosphate, $Na_7F(PO_4)_2$ $19H_2O$. The $Al(OH)_3$ is present in the hydrated form as Gibbsite, and probably in lesser quantities as other hydrates. Sodium fluoride phosphate is present as large crystals while the hydrated aluminum hydroxide is present in hardened agglomerations that resist being broken up when hit with solution from the current sluicer design.

Sodium fluoride phosphate can be slowly dissolved in water. The aluminum oxides/hydroxides agglomerations have been shown in the lab to break down with time under 19M NaOH to form sodium aluminate solids, Na_2O Al_2O_3 ($NaAlO_2$), which can then be dissolved with water. Lab testing has developed a procedure that dissolves >95% of the C-108 heel in the lab. The water dissolution of the sodium fluoride phosphate was begun in mid-October 2011 and was completed in February 2012.

Use of large quantities of oxalic acid or sodium hydroxide can have negative impacts on both DST storage space and Waste Treatment and Immobilization Plant (WTP) operation, although changes to WTP pretreatment steps may reduce the negative impact of extra sodium hydroxide.

The AREVA CORD® UV©[1] process, a chemical dissolution method that destroys excess oxalic acid, has been proposed for use in hard-to-remove sludge heel. If this process proves operable, it would eliminate some of the negative impacts of oxalic acid use.

C.3 REFERENCES

74A10-WSC-08-152, 2008, “Results of Testing Performed to Characterize Tank S-112 Heel Solids” (internal letter from W. S. Callaway, G. A. Cooke, and D. L. Herting to J. N. Appel and W. B. Barton, June 18), CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-40545, 2021, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-43107, 2009, *MARS Technology Phase II Qualification Test Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-50506, 2011, *MARS-V Technology Qualification Test Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-58514, *Tank 241-C-107 Residual Waste Inventory Estimates for Component Closure Risk Assessment.*

WHC-EP-0352, 1990, *Single-Shell Tank Waste Retrieval Study*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D –
EQUIPMENT AND TRANSFER LINES NEEDED FOR RETRIEVAL AND WASTE RECEIPT FACILITY ASSUMPTIONS

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LIST OF TERMS

Abbreviations and Acronyms

CH-TRU	contact handled transuranic
DST	double-shell tank
HIHTL	hose-in-hose transfer line
SST	single-shell tank
WRF	waste receipt facility

D.0 INTRODUCTION

This appendix provides a brief overview of the facilities and equipment needed to support the retrieval processes described in Appendix C. A conceptual design has not been completed for any retrieval equipment layout beyond A/AX Farm, C Farm and two S Farm tanks to date, and thus the arrangements for other tanks could differ from that described. This description is provided so the reader can better understand the overall waste retrieval picture.

The general term ‘diversion box’ (in different forms also referred to as a valve box, transfer pit, or similar term) in the following subsections refers to an above- or below-grade steel or concrete containment structure connected to one or more incoming transfer line(s), which can route solutions through a valving arrangement to one or more outgoing lines.

Single shell tank (SST) waste retrieval can be viewed as occurring from two individual tank farms (C, U) and from four tank farm groupings (A/AX, B/BX/BY, S/SX, and T/TX/TY). A probable waste transfer system overview is shown in Figure 3-3 of ORP-11242, *River Protection Project System Plan*, Rev. 6. This figure shows general line routing only, not individual lines. Each line in the figure represents one or more transfer lines. Hose-in-hose transfer lines (HIHTL) will be used to route retrieved waste solutions from an SST to nearby diversion boxes located within or near each tank farm or tank farm grouping. From the diversion boxes, HIHTLs or double-encased stainless steel lines will route the waste direct to double shell tanks (DSTs) or to local waste receipt facilities (WRFs) followed by transfer to DSTs. The selection of HIHTLs or double-encased stainless steel lines will be dependent on how long the line will be required to remain in service.

For the B and T Farm tanks containing material to be treated as contact-handled transuranic (CH-TRU) waste, the retrieved solution is sent to the nearby CH-TRU facility, not a DST.

Sections D.1 through D.5 provide a general description of the arrangement for each tank farm or tank farm grouping.

D.1 A/AX TANK FARMS

The waste in A/AX tanks will be retrieved and transferred via HIHTLs through new diversion boxes and then via HIHTLs from the boxes to DST storage. Current planning is for the AX Farm waste to go to DST AZ-102 and the A Farm waste to go to DST AP-101. The DST supernate used for waste mobilization will be routed from the receiver DST to the A Farm SST via the diversion boxes.

D.2 B/BX/BY TANK FARMS

The waste in the B/BX/BY tank farm grouping, except that handled as CH-TRU, will be retrieved and transferred via HIHTLs to new diversion boxes. From the new diversion boxes the waste will go via HIHTLs or double-encased stainless steel lines to a new WRF located nearby. Supernate used for waste mobilization will preferably be generated at the B/BX/BY complex by dissolution of saltcake with water, but could be supplied from a DST to a WRF tank and sent from the WRF tank to the SST.

Retrieval of SST wastes, except that handled as CH-TRU, will be to a WRF tank. Waste in the B Farm tanks that will be handled as CH-TRU waste will be transferred directly from the SST to the CH-TRU treatment plant located nearby.

D.3 S/SX TANK FARMS

The waste in S/SX tanks will be retrieved and transferred to DST storage via HIHTLs to one or more new diversion boxes and then via double-encased HIHTLs or stainless steel lines from the boxes to DST storage in SY Farm. The DST supernate required for waste mobilization will be routed from SY Farm back to the S/SX SST via the diversion boxes. If waste retrieval is required before the new lines and diversion boxes are built, retrieval can take place using HIHTLs directly from the S/SX SST to SY Farm similar to the layouts used for waste retrieval from S-112 and S-102.

D.4 T/TX/TY TANK FARM

The waste in the T/TX/TY tank farm grouping, except that handled as CH-TRU, will be retrieved and transferred via HIHTLs to new diversion boxes. From the new diversion boxes the waste will go via new double-encased HIHTLs or stainless steel lines to a WRF located nearby. Supernate used for waste mobilization will preferably be generated at the T/TX/TY complex by dissolution of saltcake with water, but could be supplied from an SY DST to a WRF tank and sent from the WRF tank to the SST.

Retrieval of SST wastes, except that handled as CH-TRU, will be to a WRF tank. Waste in the T Farm tanks that will be handled as CH-TRU waste will be transferred directly from the SST to the CH-TRU treatment plant located nearby.

D.5 U TANK FARM

U Farm retrieval will use HIHTLs routed from individual SSTs to one or more new diversion boxes. From the diversion boxes, new double-encased HIHTLs or stainless steel lines will be routed to a new diversion box adjacent to U Farm where they connect with the new double-encased lines from the T/TX/TY WRF and to/from SY Farm. The DST supernate required for waste mobilization will be routed from SY Farm back to the U Farm SSTs via the diversion boxes.

D.6 WASTE RETRIEVAL FACILITIES

There will be two WRFs built, one in 200 East Area near B/BX/BY Farms and the second in 200 West Area near T/TX/TY Farms. Each WRF will contain new receipt and transfer tanks. The number and size of these tanks will be determined in design. Each WRF will be used to receive the waste retrieved from the 100-series tanks in the adjacent tank farm complex and provide lag storage for the waste prior to being transferred periodically to a DST or the supernate being returned to the SSTs for sludge sluicing. There are 36 100-series tanks in each complex. The waste in the four 200-series tanks in each complex is currently planned to go to a separate packaging facility. Retrieved waste will be transferred from a WRF tank to DST storage via new stainless steel lines. Waste transferred from the WRF near T/TX/TY Farms will go to a new diversion box outside U Farm (where the U Farm waste can be valved into the same transfer lines) and from there to SY Farm.

Conceptual designs have not been prepared for either the B/BX/BY or T/TX/TY WRFs, nor have plans been developed as to how the WRFs will be operated. A general description of the planned WRFs is provided in Interoffice Memo 82400-99-076, *Documentation for SST Retrieval Scope in Phase II*, 1999. The reference gives few details as to how the facilities will operate however.

The WRFs should provide satisfactory operation for receipt and transfer of dissolved salt solution. Use of the WRFs for retrieval of sludge slurry solutions may be more problematic. Sludge sluicing from an SST direct to a DST is enabled by the adequate room in a 1 Mgal DST for sludge to settle out while the supernate is recycled for more sluicing. Sludge sluicing to a 150 kgal WRF tank may not provide adequate room for sludge to settle, resulting in a high sludge loading in the recycled supernate unless a mechanical liquid-solid separator is used. This problem needs to be evaluated and a proposed operating methodology established for the WRFs. One alternative would be to use most of the WRF tanks for supernate storage. The supernate would be used for sluicing an SST, but instead of recycling the sludge slurry to a WRF tank for separation of the sludge and supernate the sludge slurry would be sent directly to a DST, or to a WRF tank for very short lag storage before being transferred to a DST. Any separation of the sludge from the supernate would be done in the receiving DST. Supernate stored in the WRF tanks would come either from SST salt dissolution or be recycled back from a DST.

The assumption is made that the WRFs can be designed and operated satisfactorily. See Assumption 9.20 and Requirement 11.3 in the main body of this document.

See Recommendation 10.5 in the main body of this document concerning increasing the scope of one or both WRFs to include decontamination, repair, and storage capability for failed pumps and other tank farm equipment.

D.7 REFERENCES

Interoffice Memo 82400-99-076, 1999, *Documentation for SST Retrieval Scope in Phase II*, Garfield, J. S., to Stokes, W. J., Lockheed Martin Hanford Company, Richland, Washington.

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

APPENDIX E –
TANKS REQUIRING SPECIAL CONSIDERATION

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LIST OF FIGURES

LIST OF TERMS

Abbreviations and Acronyms

ALC	air lift circulator
ERSS	extended reach sluicing system
ERSS-HPW	extended reach sluicing systems with high pressure water
HTRH	hard-to-remove heel
ITV	in-tank vehicle
MARS	mobile arm retrieval system
MARS-S	mobile arm retrieval sluicing system
MARS-V	mobile arm retrieval vacuum system
MRS	mobile retrieval system
SST	single-shell-tank
TWINS	Tank Waste Information Network System

E.0 INTRODUCTION

A number of single-shell tanks (SSTs) will require special consideration when planning for and conducting retrieval operations. This appendix lists tanks currently identified as requiring special consideration and provides a brief description of the reason for concern. The currently identified tanks include:

- All A Farm tanks
- A-105 (in addition to listing above)
- All AX Farm tanks
- B-105
- BY-105
- SX-101
- SX-115
- U-101
- TX-117 and A-101 (in addition to listing above)
- BY-103, TX-105, TX-110, TX-114.

E.1 DESCRIPTION OF SPECIFIC TANK CONCERNS

E.1.1 ALL A FARM TANKS

The A Farm tanks all have flat bottoms and have ripples along the tank bottom. Except for A-105, which has a torn liner. The elevation of these ripples is unknown, but likely results in less than 20 ft. between the bottom of the downcomer and the tank bottom. No mobile arm retrieval sluicing system (MARS-S) or mobile arm retrieval vacuum system (MARS-V) have currently been designed for A Farm tanks. The A Farm tanks are over 12 ft deeper than the C Farm tanks, and the increased depth may result in a design requiring more than 15 ft of clearance below the bottom of the in-tank opening.

Since the last revision of this document, experience has been gained deploying and operating extended reach sluicing systems with high pressure water (ERSS-HPW). The ERSS-HPW has been used in AX-102, C-101, C-102, C-105 heel, C-111 heel and C-112. Typically two ERSS sluicers where installed in each tank, but more will need to be installed in each A-Farm tank so the nozzle spray will not be obstructed by the air lift circulators. The ERSS has shown that high pressure spray can be put in close proximity to the waste in the tanks.

Figure E-1 is a sketch of the A Farm tanks showing the downcomer and the space available between the waste height in each tank and a MARS-S arm. The MARS-S and the MARS-V systems designed for C Farm tanks require 15 ft of clearance below the bottom of the in-tank opening in order to be installed. If the tank bottom hasn’t bulged, there appears to be sufficient clearance for insertion of a MARS-V unit into A-104 if it has the same clearance requirement as the one used in C Farm.

It is uncertain whether a MARS-V system can be installed into A-105. Based upon stereo images made of the A-105 tank bottom in the 1970s, the bottom has a bulge estimated at between 2 and 3 ft near the tank center (see E.1.2). The liner peak height is estimated to be between 8 and 9 ft. The brown area in Figure E-1 is an estimate of the A-105 tank bottom height based upon stereo image information from 1978 (data summarized in WHC-MR-0264, 1991, *Tank 241-A-105 Leak Assessment*, 1991). If the A-105 liner height is at the height estimated in the 1978, the MARS could fit into the tank with a foot or two clearance (at the most) if the arm is oriented away from the bulged area during installation. If the MARS-V will not fit, the downcomer must be removed to retrieve the tank, as the mobile retrieval system (MRS) in-tank vehicle would not be a practical alternative to use for retrieval in this tank.

A process for cutting through the downcomer in vertical strips has been scoped out, with installation of a tool in the tanks to ensure these strips fall away from the center of the tank when cut off. A process will have to be developed and tested to validate that the MARS-V can be installed in any of the A farm tanks (see Requirement 11.8 in the main body of this document). If the downcomer in A-105 can't be removed and the liner is bulged more than indicated from the 1970s stereo images, the only viable current retrieval process for A-105 would be a combination of sluicing and chemical dissolution.

E.1.2 A-105

Tank A-105 experienced a steam release in 1965 and the bottom of the tank liner bulged upwards. The liner appears ruptured around much of the tank circumference. The tank held significant waste until the supernate was pumped out and the sludge was repeatedly sluiced in the 1968 to 1970 period. Inhibited sulfuric acid was used to soften and aid removal of some of the hard sludge in the tank in 1969-1970. Cooling water was added to the tank up until 1978, with most of it believed to have evaporated. The addition of liquid to this tank during retrieval will need to be performed carefully. The presence of 4 air lift circulators (ALCs) of different heights complicates the use of the MARS-V in the tank but should not unduly inhibit its operation.

Assuming the MARS-V can be installed (see E.1.1), the MARS-V as currently designed may not be able to reach all the waste in the tank. Figure E-2 is a sketch of A-105 with a MARS-V unit installed. The left figure shows which areas of the tank bottom the MARS-V head should be able to reach and which areas it may not reach due to the tank bottom distortion, based upon the 1978 information.

While it is likely that a MARS-V unit can retrieve much of the visible waste in the tank, it may not be able to retrieve the waste in the areas shown as red in Figure E-2, nor may it retrieve much waste under the liner. WHC-MR-0264 provides more 1978 information that estimate 4,300 to 6,300 ft^3 of waste remain in the tank. Of this, 2,000 to 4,000 ft^3 were assumed under the liner. The estimate of the volume under the liner appears to have been made based upon observed temperatures, evaporation estimates, and estimated sludge heat generation rates. In 2017 a video inspection of the tank was conducted, a Video Camera/CAD Modeling evaluation used these videos to estimate the total volume of residual wasted on the liner of the tank. It is estimated approximately 335 ft^3 of waste remains on the liner with 43 ft^3 of waste on the tank walls and

stiffener rings, EDT-851608, *CCMS Residual Waste Surface Volume Tank 241-A-105*. There is no recent estimate of the volume under the liner.
Chemical dissolution is the only viable current process to remove material under the A-105 liner. Other retrieval processes for waste under the liner are not considered in this document.

Another potential problem was recently identified for this tank. Internal Letter WRPS-1100725, *Ammonium Nitrate in Tank 241-A-105*, discusses the presence of significant growths of what is postulated to be ammonium nitrate or related compounds on the surface of a number of items in the tank vapor space. The letter states that there is probably little problem posed by the crystal formations under credible tank conditions. This evaluation was limited to current waste storage conditions; no safety basis level evaluation has been done concerning risks associated with retrieval operations or related construction work in the tank.

E.1.3 ALL AX FARM TANKS

All AX Farm tanks have ripples along the tank bottom of the tank. Through experience with AX-102 retrieval it was seen that the ripples hinder the pump down at the end of the retrieval causing the pump to possibly be at a higher elevation and allow more liquid to be left. Also seen was waste collecting behind the ripples and not being pushed to the pump. Each AX tank contains 22 ALCs that are embedded in the tank dome and extended to within 30 in. of the tank floor at the time of construction. The AX tank ALCs also have a thermocouple attached to the outside which extends down to the tank bottom. The ERSS-HPW will have the mobility required to maneuver these obstructions. During AX-102 retrieval it was seen that the ERSS had no major issues maneuvering around the ALC's. Any in-tank vehicle (ITV) used for hard-to-remove heel (HTRH) retrieval is assumed impractical as the vehicle umbilical cord would get hung up on the ALCs or the thermocouples extending down from the ALCs. The HTRH retrieval in these tanks is assumed using chemical dissolution for the sludge heel, for saltcake HTRH low efficiency dissolution with recirculation is preferred. Figure E-3 is a photo of the ALCs in an AX tank during construction.

E.1.4 B-105

Tank B-105 is designated as being an assumed leaker as it was one of the Questionable Integrity tanks recategorized as being an assumed leaker in the early 1980s. There is no evidence the tank leaked other than some unexplained level drops. Figure E-4 is the Tank Waste Information System (TWINS) photo mosaic for the tank. Looking at Figure E-4, it is obvious that surface level measurement irregularities would be expected from the tank with the irregular saltcake layers. It is also evident that an MRS or MARS-V retrieval device would be impractical for the tank due to the shape of the saltcake in the tank. Currently, an ERSS-saltcake dissolution or MARS-S process are the only useful processes available for B-105. Since the tank does not have a 42-in. central riser, ERSS is the logical choice. The tank status needs to be recategorized if possible. If not, procedures will have to be developed for using ERSS in the tank that will meet regulatory concurrence.

E.1.5 BY-105

Portland cement was added to tank BY-105 in 1966, and possibly in 1977. The 1966 addition was done to absorb liquid (ISO-610, *Chemical Processing Division Monthly Report for November, 1966*). Internal Memo 71330-95-004, *Portland Cement in Tank 241-BY-105*, calculated this to be approximately 81 tons of cement. This addition was made when the tank waste inventory was about one-third the current waste depth. WHC-MR-0132, *A History of the 200 Area of Tank Farms*, states that 63 tons of cement was added to BY-105 in 1977, but no confirming information has been noted in a corresponding monthly report. The monthly waste status summary reports for March 1977 through February 1978 had the comment "63T CEMENT ADD" for BY-105. If there was cement added in 1977, it would be at the top of the current tank waste level. A layer that was quite hard to penetrate with rotary mode core sampling was present during core sampling of BY-105 in 1995 and 1998.

With the testing performed late in 2009 for the MARS-S (RPP-RPT-43107, *MARS Technology Phase II Qualification Test Report*), it appears that the high pressure water sprays on the MARS-S head should be effective at breaking up grout. Table 6-1 indicates the tank is to be retrieved using MARS-V. The high pressure sprays on the MARS-V head should be as effective as those on the MARS-S in breaking up cement layer(s) in the tank. BY-105 is another questionable integrity tank that was recategorized in the early 1980s as an assumed leaker without any definite evidence the tank leaked. Recommendation 10.4 in the main body of this document includes re-evaluation of the BY-105 leak status.

E.1.6 SX-101

SX-101 contains a large concentrator in the central 42-in. tank riser. This unit was installed before waste was first added to the tank in 1954. Drawing H-2-39599, *241-SX Waste Self-Concentrator Test Facility*, shows this unit located in a containment cylinder that is welded to the tank bottom. The drawing also shows a fill line extending from the tank wall to the concentrator. While this fill line could possibly be cut through remotely to potentially remove the concentrator, the containment cylinder will still be welded to the tank bottom. If means can't be developed to remove this cylinder, the central 42-in. riser can't be used for any equipment that needs to extend below the tank dome space, which would preclude use of MARS-S for the tank.

Based upon three separate sources (see RPP-40545, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, Appendix H) it is evident that there is a very nonporous and dense 40- to 60-in.-thick salt layer at the bottom of SX-101. The saltcake is believed to be solid crystalline material.

E.1.7 SX-115

SX-115 only has an estimated 4 kgal of waste. It is a known leaking tank and had the highest estimated leak rate of any leaking Hanford tank (306 gph per HNF-4872, *Single Shell Tank Leak History Compilation*). Putting liquid in this tank for retrieval will have to be performed very carefully since with this leak rate, there may be a fair sized opening where the tank liner is breached. An in-tank video from 1996 shows some liquid present in a depression under a riser, so the tank will contain some liquid. The tank has four ALCs attached to the tank bottom.

The MARS-V is assumed used for this tank should be able to maneuver around them. The tank has a significant film of salt on the tank walls which will have to be carefully washed off. Retrieval in this tank will require planning to avoid areas where the tank bottom may be breached.

E.1.8 U-101

U-101 is a known leaking tank that has a number of N-Reactor fuel elements plus solid reactor waste on the tank bottom. An in-tank video taken during sampling in the mid-1990s showed these fuel elements as well as liquid on the tank bottom. The presence of liquid many years after the 1959 date when the tank was first believed to leak is a good indication that the tank may not have a breach on the tank bottom. The tank is shown in Tables 6-1 and 6-2 to use MRS for retrieval, but use of an ITV may be difficult in this tank. Use of a MARS-V system would require installation of a 42-in. central riser. No plans are included in this document for removing the fuel elements or reactor hardware.

E.1.9 TX-117

Tank TX-117 was identified in DOE report, *Assessment of the Surveillance Program of the High-Level Waste Storage Tanks at Hanford*, and HNF-4872 as being of concern for dome loading due to a radial crack in the tank dome. This radial crack was observed in photographs 695054-6CN, dated 1969 and 700442-28CN. This crack has not been evaluated for the impact of retrieval equipment on tank stability. MARS-V system is extremely heavy and its use on these tanks may be precluded if adequate support for the equipment cannot be ensured. See Requirement 11.2 in the main body of this document.

E.1.9 BY-103, TX-105, TX-110, TX-114

These tanks are all assumed leaking tanks with too much waste volume to use an MRS system for retrieval. They all have a 42 in. central riser where a MARS-V system could be installed, except for the central riser having a post-construction ALC added. The ALCs are embedded in saltcake and it is unlikely that they could be removed with a crane. Since the tanks are assumed leakers it may not be prudent to add a significant amount of water to the area around the ALC to break it loose. A method will need to be developed for removing the ALCs or for cutting them off and positioning a MARS-V unit above the top of the cut off ALC. See Requirement 11.1 in the main body of this document.

E.2 REFERENCES

ARH-R-43, 1970, *Management of Radioactive Wastes Stored in Underground Tanks at Hanford*, Rev. 2, Harvey, R. W., Atlantic Richfield Hanford Company, Richland, Washington.

Catlin, R.J., 1980, *Assessment of the Surveillance Program of the High-Level Waste Storage Tanks at Hanford*, report to the U.S. Department of Energy Assistant Secretary for Environment, U.S. Department of Energy, Washington, D.C.

EDT-851608, 2018, *CCMS Residual Waste Surface Volume Tank 241-A-105,* Rev. 0, Washington River Protection Solutions LLC., Richland, Washington.

H-2-39599, 1954, *241-SX Waste Self-Concentrator Test Facility*, March, 1954, U.S. Atomic Energy Commission Hanford Atomic Products Operation, General Electric, Richland, Washington.

HNF-4872, 1999, *Single-Shell Tank Leak History Compilation*, Rev. 0, prepared for Lockheed Martin Hanford Company, Richland, Washington, by Vista Research, Inc., Richland, Washington.

Internal Memo, K.M. Hodgson to N.W. Kirch, et al, "Portland Cement in Tank 241-BY-105," 71330-95-004, dated March 29, 1995.

ISO-610, 1966, *Chemical Processing Division Monthly Report for November, 1966*, December 1966, ISOCHEM Inc., Richland, Washington.

Memorandum, G.E. Reeploeg to N.W. Kirch, et al, "Ammonium Nitrate in Tank 241-A-105," Rev. 1, WRPS-1100725, dated April 25, 2011.

Photograph 8505749-4CN, IDMS Accession No. N2037561 for A-101, 1985.

Photographs 695054-6CN, dated 1969 and 700442-28CN for TX-117, the photos are not in IDMS.

RPP-40545, 2021, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, Washington River Protection Solutions LLC, Richland, Washington.

RPP-RPT-43107, 2009, *MARS Technology Phase II Qualification Test Report*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

Tank Waste Information Network System, (TWINS), http://twinsweb.pnl.gov/twins.htm

WHC-MR-0132, 1990, *A History of the 200 Area Tank Farms*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0264, 1991, *Tank 241-A-105 Leak Assessment*, Westinghouse Hanford Company, Richland, Washington.

Figure E-1. Cross-Section of A Farm Tanks Showing Waste Heights and Assumed Clearance for MARS Installation.

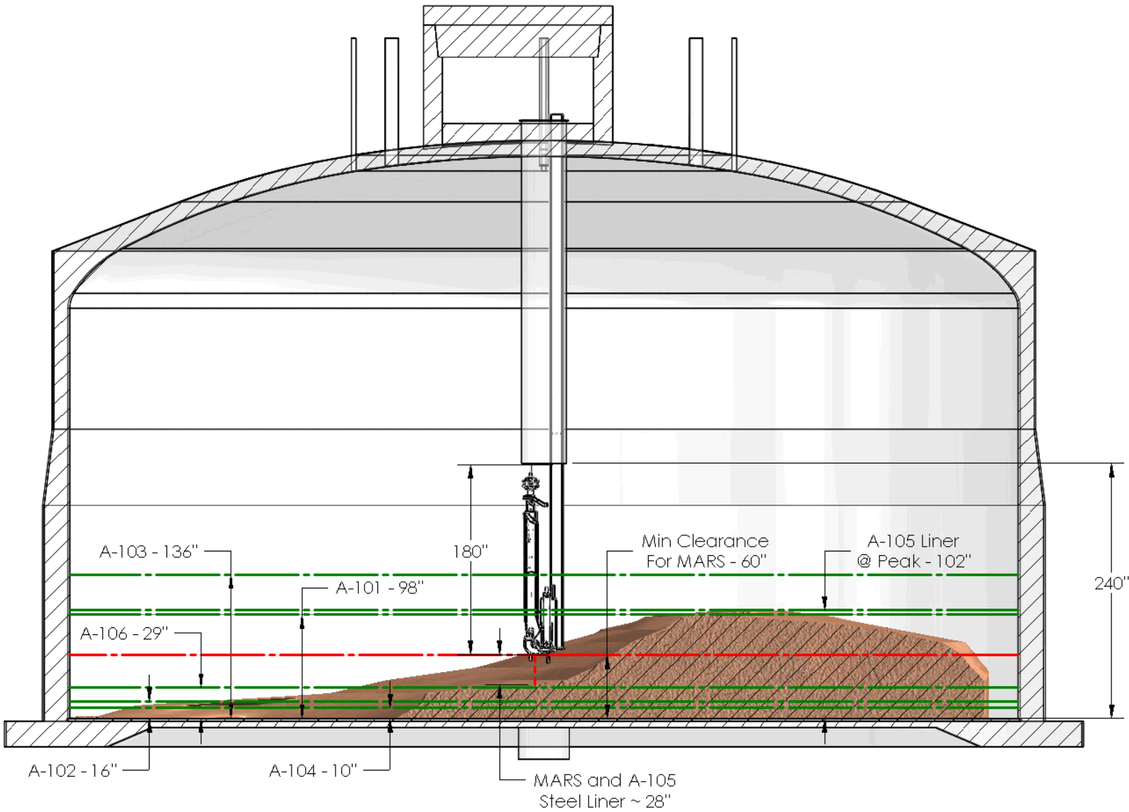


Figure E-2. Top and Side Views of Tank A-105.

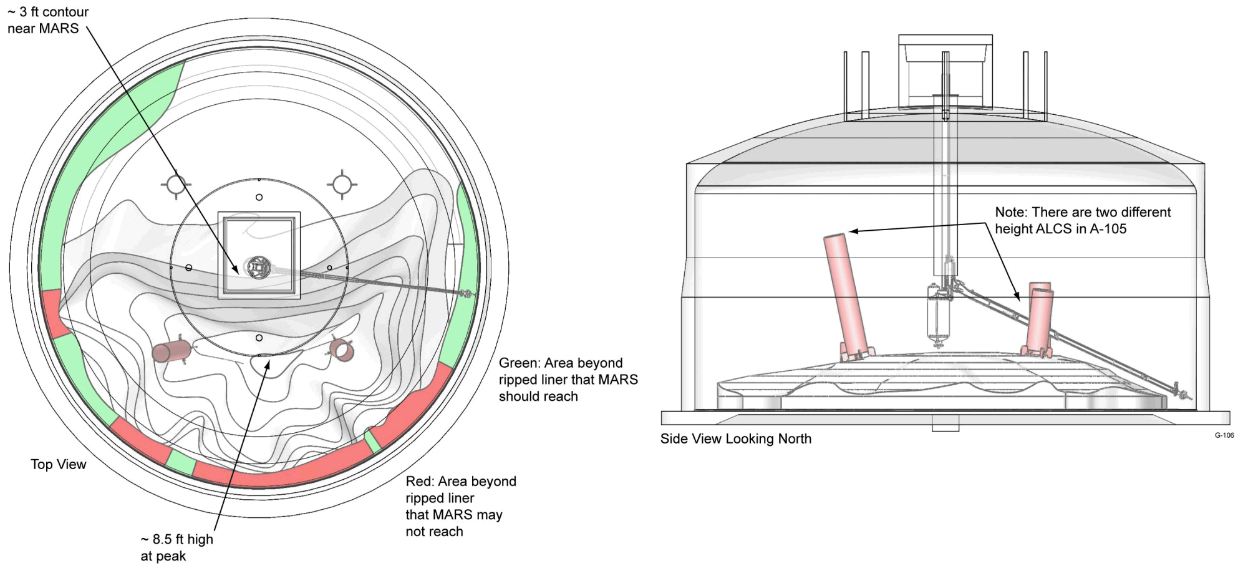
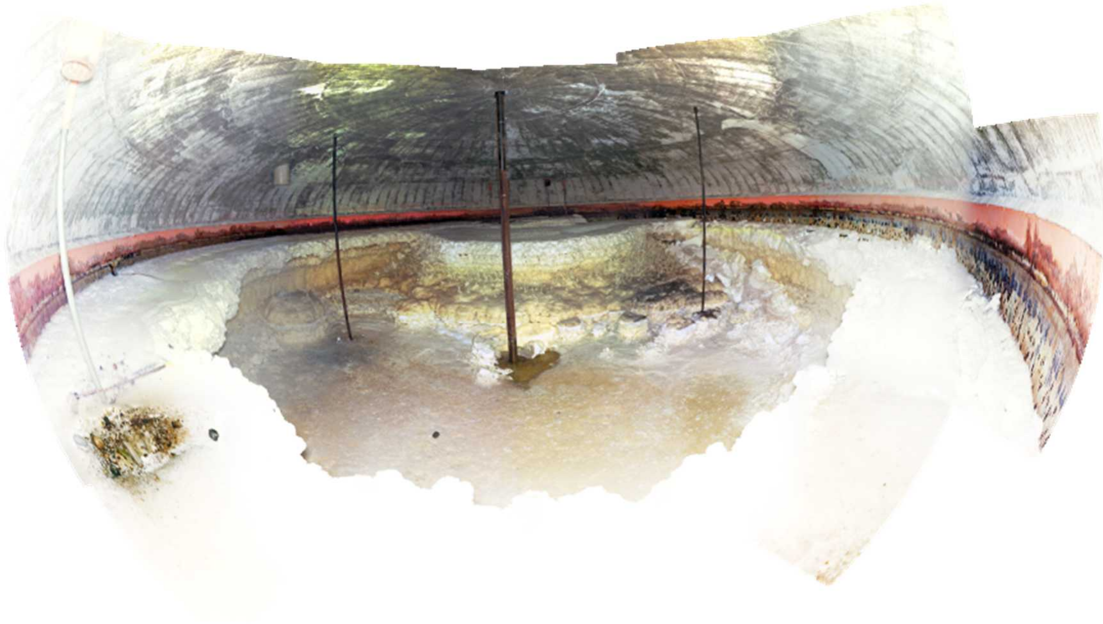


Figure E-3. AX Farm Tank During Construction

Figure E-4. Tank B-105 Photo Mosaic



APPENDIX F – LIST OF TANKS WITH NO SAMPLING, SALTWELL PUMPING OR LIQUID OBSERVATION WELL INFORMATION

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Abbreviations and Acronyms

BBI	Best-Basis Inventory
DST	double-shell tank
LOW	liquid observation well
SST	single-shell-tank
TWINS	Tank Waste Information Network System

F.0 INTRODUCTION

Single-Shell tank (SST) waste retrieval planning relies primarily upon the following:

- Best Basis Inventory (BBI) waste volumes and compositions
- Tank solids sampling (core sampling, auger sampling, finger trap or other solid samples) physical information (i.e., sample recovery and what waste related problems may have been encountered during sampling)
- Tank liquid observation well (LOW) gamma and neutron scan data
- Tank saltwell jet pumping information
- Information gleaned from historical records or personnel knowledge.

The BBI waste volumes and compositions are based upon the sample analysis data from tanks which were sampled, and on waste templates, tank fill history, or other information for tanks which were not sampled.

There are a number of tanks with no solids sampling information, no LOW data, and no saltwell pumping information. This leaves SST waste retrieval planning to rely solely upon waste templates, tank fill history, and other historical information for these tanks. Relying only upon assumed information is a tenuous basis for waste retrieval planning. Section F.1 provides a summary of the available information so potential planning weaknesses can be noted. Saltwell pumping is completed and it is doubtful whether any more LOWs installations are warranted, but samples can be obtained from the tanks if funding is available.

F.1 AVAILABILITY OF SST SOLIDS SAMPLING, LOW DATA, OR SALTWELL PUMPING INFORMATION

Table F-1 lists all SSTs and whether the tank has post-1989 core sampling information (pre-1989 sampling information does not meet regulatory requirements and the BBI information is not always complete), any other solids sampling information (auger samples, finger trap samples, pre-1989 core samples), and whether the tank has LOW or saltwell jet pumping information. Table F-1 is current to July 13, 2020. All tanks have been interim stabilized either administratively (i.e., on paper, no pumping performed), supernate pumped only, or jet pumped. Jet pumping information is the only saltwell pumping information useful in trying to estimate the retrievability of waste in a tank.

In Table F-1, tanks are color coded as follows:

- Tanks shaded green have
  - post 1989 core sampling information
  - post 1989 auger or other solids sampling information and <~30 kgal waste in dish bottom tanks or <~50 kgal in flat bottom tanks (~20 in.).

- Tanks shaded light blue have
  - pre 1989 core sampling information, excluding the TX-116 1976 core skid sampling, or
  - post 1989 auger or other solids sampling information and >~30 kgal but <60 kgal waste in dish bottom tanks or >~50 kgal but <80 kgal in flat bottom tanks (~20 to ~30 in.).
- Tanks shaded yellow have
  - post 1989 auger or other solids sampling information and >~60 kgal waste in dish bottom tanks or >80 kgal in flat bottom tanks.
  - LOW or LOW plus saltwell pumping information only.
- Tanks shaded red have no sampling information, no LOW information, and no saltwell pumping information.
- Tanks shaded grey have completed retrieval or retrieval is in progress and any further sampling done will be determined by retrieval operations considerations.

The sampling information in Table F-1 is weighted more to information about the sampling event rather than the sample data. e.g., C-111 is shown as green, yet the 1995 core sample yielded little useful sample material, as did 3 of the 4 auger samples. The physical information obtained from the sampling events indicated retrieval of the waste in this tank was going to be difficult, even though little sample data were garnered from the sample material.

The criteria used for Table F-1 are based upon the author's judgment only, and may not be a valid assessment of the information available for each specific tank. Overall however, the table is felt to show a reasonable picture of the level of confidence available from current information. Table F-1 has 85 tanks shaded green, 14 shaded light blue, 24 shaded yellow, 9 shaded red, and 17 shaded gray.

All information in Table F-1 came from Appendix H of RPP-40545, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*.

F.2 REFERENCES

RPP-40545, 2021, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, Rev. 6, Washington River Protection Solutions, LLC., Richland, Washington.

Table F-1. Summary of Single-Shell Tank Solids Sampling, Liquid Observation Well, or Saltwell Jet Pumping Information (5 Sheets)

Tank	Total Waste Volume (kgal)	Post 1989 Core Sample	Other Solids Sample Information	LOW Data	Saltwell Jet Pumped
A-101	331.5	Yes	No	Yes	Yes
A-102	40.9	No	auger, 1986 core sample	No	No
A-103	388.6	No	1986 core sample	Yes	No
A-104	27.7	No	1986 core sample	No	No
A-105	19.8	No	No	No	No
A-106	79.3	No	1986 core sample	Yes	No
AX-101	359.5	Yes	No	Yes	Yes
AX-102	10.6	No	auger	No	No
AX-103	103.8	Yes	No	Yes	No
AX-104	25.6	No	auger, finger trap	No	No
B-101	104.9	Yes	No	Yes	No
B-102	30.9	No	auger	No	No
B-103	38.0	No	auger	No	No
B-104	368.8	Yes	No	Yes	No
B-105	290.1	No	No	Yes	No
B-106	117.0	Yes	No	No	No
B-107	156.7	Yes	No	Yes	No
B-108	86.4	Yes	No	Yes	No
B-109	121.8	Yes	No	Yes	No
B-110	244.1	Yes	No	Yes	No
B-111	245.6	Yes	No	Yes	No
B-112	34.18	No	auger	No	No
B-201	29.6	Yes	No	No	No
B-202	29.1	Yes	No	No	No
B-203	50.2	Yes	No	No	No
B-204	49.4	Yes	No	No	No
BX-101	51.5	No	auger	No	No
BX-102	88.8	No	No	No	No
BX-103	74.0	Yes	No	No	No
BX-104	97.2	Yes	1986 core sample	No	No
BX-105	70.5	No	auger, 1986 core sample	No	No
BX-106	36.5	No	auger	No	No
BX-107	343.2	Yes	No	No	Yes
BX-108	29.9	No	auger	No	No
BX-109	188.6	Yes	No	Yes	Yes
BX-110	212.4	Yes	auger	Yes	No

Table F-1. Summary of Single-Shell Tank Solids Sampling, Liquid Observation Well, or Saltwell Jet Pumping Information (5 Sheets)

Tank	Total Waste Volume (kgal)	Post 1989 Core Sample	Other Solids Sample Information	LOW Data	Saltwell Jet Pumped
BX-111	124.2	Yes	No	Yes	Yes
BX-112	157.7	Yes	auger	No	Yes
BY-101	365.6	Yes	No	Yes	Yes
BY-102	315.4	Yes	No	Yes	Yes
BY-103	408.1	No	auger	Yes	Yes
BY-104	400.8	Yes	No	Yes	Yes
BY-105	476.81	Yes	No	Yes	Yes
BY-106	428.8	Yes	No	Yes	Yes
BY-107	272.6	Yes	No	Yes	Yes
BY-108	216.9	Yes	No	Yes	Yes
BY-109	295.5	Yes	No	Yes	Yes
BY-110	348.7	Yes	No	Yes	Yes
BY-111	398.1	Yes	No	Yes	Yes
BY-112	286.9	Yes	No	Yes	Yes
C-101	5.4		auger	No	No
C-102	15.5	No	auger, 1986 core sample	No	Yes
C-103	2.5	Yes	1986 core sample	No	Yes
C-104	1.9	Yes	1986 core sample	No	No
C-105	1.6	Yes	1986 core sample	No	No
C-106	2.8	No	1986 core sample	No	No
C-107	10.2	Yes	No	No	Yes
C-108	3.4	Yes	No	No	No
C-109	1.7	Yes	No	No	No
C-110	2.1	Yes	No	No	Yes
C-111	4.9	Yes	auger	No	No
C-112	9.9	Yes	No	No	No
C-201	0.1	Yes	No	No	No
C-202	0.1	No	auger	No	No
C-203	0.1	No	auger	No	No
C-204	0.1	No	auger	No	No
S-101	351.1	Yes	No	Yes	Yes
S-102	93.0	Yes	No	Yes	Yes
S-103	230.1	No	No	Yes	Yes
S-104	281.3	Yes	No	Yes	No
S-105	508.3	Yes	No	Yes	Yes
S-106	450.9	Yes	No	Yes	Yes

Table F-1. Summary of Single-Shell Tank Solids Sampling, Liquid Observation Well, or Saltwell Jet Pumping Information (5 Sheets)

Tank	Total Waste Volume (kgal)	Post 1989 Core Sample	Other Solids Sample Information	LOW Data	Saltwell Jet Pumped
S-107	358.2	Yes	No	Yes	Yes
S-108	541.8	No	No	Yes	Yes
S-109	532.8	Yes	No	Yes	Yes
S-110	387.3	Yes	No	Yes	Yes
S-111	400.5	Yes	No	Yes	Yes
S-112	2.4	Yes	No	Yes	Yes
SX-101	416.3	Yes	No	Yes	Yes
SX-102	341.8	Yes	No	Yes	Yes
SX-103	599.4	Yes	No	Yes	Yes
SX-104	427.4	No	No	Yes	Yes
SX-105	375.1	Yes	No	Yes	Yes
SX-106	268.4	Yes	No	Yes	Yes
SX-107	96.4	No	No	No	No
SX-108	79.3	No	auger	No	No
SX-109	243.6	No	1986 core sample	No	No
SX-110	58.1	No	No	No	No
SX-111	117.0	No	No	Yes	No
SX-112	71.3	No	No	Yes	No
SX-113	19.3	No	auger	No	No
SX-114	157.7	No	No	No	No
SX-115	4.0	No	finger trap	No	No
T-101	93.3	No	No	Yes	No
T-102	30.1	Yes	No	No	No
T-103	26.4	No	No	No	No
T-104	310.1	Yes	No	Yes	Yes
T-105	91.7	Yes	No	No	No
T-106	21.1	No	auger	No	No
T-107	167.0	Yes	No	No	Yes
T-108	15.1	No	auger	No	No
T-109	98.0	No	auger	Yes	No
T-110	352.9	Yes	No	Yes	Yes
T-111	424.0	Yes	No	Yes	Yes
T-112	62.6	Yes	No	No	No
T-201	31.2	Yes	No	No	No
T-202	19.5	Yes	No	No	No
T-203	35.9	Yes	No	No	No

Table F-1. Summary of Single-Shell Tank Solids Sampling, Liquid Observation Well, or Saltwell Jet Pumping Information (5 Sheets)

Tank	Total Waste Volume (kgal)	Post 1989 Core Sample	Other Solids Sample Information	LOW Data	Saltwell Jet Pumped
T-204	35.9	Yes	No	No	No
TX-101	87.4	No	No	No	No
TX-102	212.7	No	No	Yes	Yes
TX-103	127.9	No	No	Yes	Yes
TX-104	65.8	Yes	No	Yes	No
TX-105	599.9	No	No	Yes	Yes
TX-106	390.4	No	No	Yes	Yes
TX-107	27.5	No	auger	No	No
TX-108	116.2	No	No	Yes	Yes
TX-109	375.1	No	No	Yes	Yes
TX-110	461.2	No	No	Yes	Yes
TX-111	359.5	No	No	Yes	Yes
TX-112	626.4	No	No	Yes	Yes
TX-113	634.0	Yes	No	Yes	Yes
TX-114	521.5	No	No	Yes	Yes
TX-115	543.7	No	No	Yes	Yes
TX-116	564.8	No	1976 core sample with skid	Yes	Yes
TX-117	625.8	No	No	Yes	Yes
TX-118	249.9	Yes	No	Yes	Yes
TY-101	105.7	No	1985 core sample	No	Yes
TY-102	69.2	No	1985 core sample	No	No
TY-103	152.4	No	1985 core sample	Yes	Yes
TY-104	42.5	No	auger, 1985 core sample	No	No
TY-105	168.8	No	1985 core sample	Yes	Yes
TY-106	12.7	No	auger, 1985 core sample	No	No
U-101	30.9	No	No	No	No
U-102	341.8	Yes	No	Yes	Yes
U-103	406.8	Yes	No	Yes	Yes
U-104	84.0	No	No	No	No
U-105	350.3	Yes	No	Yes	Yes
U-106	165.1	Yes	No	Yes	Yes
U-107	277.4	Yes	No	Yes	Yes
U-108	428.2	Yes	No	Yes	Yes
U-109	389.9	Yes	No	Yes	Yes
U-110	182.8	Yes	No	Yes	No

Table F-1. Summary of Single-Shell Tank Solids Sampling, Liquid Observation Well, or Saltwell Jet Pumping Information (5 Sheets)

Tank	Total Waste Volume (kgal)	Post 1989 Core Sample	Other Solids Sample Information	LOW Data	Saltwell Jet Pumped
U-111	219.3	No	No	Yes	Yes
U-112	43.3	Yes	No	No	No
U-201	5.0	Yes	No	No	No
U-202	4.8	Yes	No	No	No
U-203	3.4	Yes	No	No	No
U-204	2.9	Yes	No	No	No

APPENDIX G –
RETRIEVAL OF WASTES FROM MISCELLANEOUS ACTIVE AND INACTIVE UNDERGROUND STORAGE TANKS

Retrieval of wastes from MUST or IMUST will be addressed within a revision to this document if incorporated into the work scope. Since 2016 (the previous revision of this document) there has been no direction to include MUST and IMUST retrievals into the work scope of this retrieval plan.