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Ms. Jane A. Hedges, Program Manager
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Washington State
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Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) SUBMITS THE RETRIEVAL COMPLETION CERTIFICATION AND REPORT FOR TANK 241-C-108

ORP is transmitting RPP-53869 Revision 2, "Retrieval Completion Certification for Tank 241-C-108" to the Washington State Department of Ecology (Ecology) in accordance with Section IV-B-5 of the Consent Decree No. 08-5085-FVS, filed October 25, 2010, which states "When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank."

This letter certifies that ORP has completed retrieval of Tank C-108 in accordance with Part 1 of Appendix C of the Consent Decree (*Washington v. DOE*, Case No. 08 5085-FVS [E. D. Wa. 0091889 October 25, 2010]) and with the retrieval technology/systems that were established by approval of Ecology on May 3, 2012, in Tank Waste Retrieval Work Plan RPP-22393, Revision 6a.

If you have any questions, please contact me, or your staff may contact Joanne F. Grindstaff, Federal Project Director, Retrieval and Closure, (509) 376-6202.

Thomas W. Fletcher, Assistant Manager
for Tank Farms Project

TF:CJK

Attachment

Distribution: see page 2

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13-TF-0025

RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-108

RPP-53869
Revision 2

Retrieval Completion Certification Report for Tank 241-C-108

L. A. Fort
M. P. Bergeron
Washington River Protection Solutions, LLC

Date Published
April 2013

washington river protection solutions

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

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RETRIEVAL COMPLETION CERTIFICATION REPORT FOR TANK 241-C-108

Pursuant to Consent Decree in Case No. CV-08-5085-FVS
(*State of Washington v. Department of Energy* [E.D. Wa. October 25, 2010])

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) is hereby submitting this Certificate of Retrieval Completion Report (hereinafter "Retrieval Completion Certification") in accordance with Section IV-B-5 of the Consent Decree in *Washington v. DOE*, Case No. 08-5085-FVS (E.D. Wa. October 25, 2010) (hereinafter the "Decree" or "Consent Decree"), which provides as follows: "When DOE completes retrieval of waste from a tank covered by this Decree, DOE will submit to Ecology a written certification that DOE has completed retrieval of that tank."

This Retrieval Completion Certification provides a summary of completion of retrieval operations on the single-shell tank (SST) 241-C-108 (C-108) on March 22, 2012. Tank C-108 was retrieved using modified sluicing and chemical dissolution (caustic cleaning) technologies as described in the Tank Waste Retrieval Work Plan (RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan*, Revision 6A) approved by the State of Washington Department of Ecology (Ecology) on May 3, 2012, to a final waste volume of ~460 ft^3. Because this volume of waste exceeded the Consent Decree goal of 360 ft^3, ORP submitted a *Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108* (RPP-52290) on August 22, 2012 in accordance with Appendix B, Part 1, of the Decree; Ecology approved this request on November 16, 2012 (12-NWP-178).

This Retrieval Completion Certification provides a summary of technical information on which the decisions to cease retrieval operations in tank C-108 were based for each of these technologies. The format and content of this Retrieval Completion Certification resulted from numerous discussions between Ecology and DOE-ORP and its Tank Operations Contractor, Washington River Protection Solutions, LLC. and an agreed-upon outline that DOE-ORP followed in preparing this document. The DOE-ORP is hereby declaring that it has completed the retrieval of tank C-108 in full compliance with the requirements of Part 1 of Appendix C of the Consent Decree, and with the retrieval technologies/systems that were established by Part 1 of the Tank Waste Retrieval Work Plan, and is submitting this Retrieval Completion Certification accordingly.

2.0 RETRIEVAL PROCESS DESCRIPTION AND CHRONOLOGY

2.1 PRE-RETRIEVAL CONDITION

Tank C-108 is a 530,000-gal (70,850-ft^3) SST that was used to store radioactive waste beginning in 1947. Prior to retrieval, the initial waste volume in tank C-108 was estimated in the Best-

Basis Inventory (BBI)[1] to contain ~66,000 gal (~8,800 ft^3) of waste that was deposited in this tank primarily during the 1940s, 1950s, and 1960s. Tank C-108 is currently classified as "sound" (i.e., surveillance data indicates no loss of liquid attributed to a breach of integrity) in HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2012*, Revision 297.

The chemical and radionuclide composition and waste inventory used in the BBI was based on the analytical laboratory results of core and auger samples obtained in 1994 and process knowledge of the types of waste that were deposited into tank C-108. The BBI identifies the waste as consisting of in-farm ferrocyanide scavenging waste (TFeCN), tributyl phosphate process waste (TBP), and bismuth phosphate first-cycle waste (1C). The BBI sludge volume was based on a number of sludge measurements taken over time at a single location in the tank. Prior to the start of the first retrieval campaign (modified sluicing) on December 20, 2006, ~2,600 gal of water were added to the tank as a result of construction support and testing.

2.2 PROCESS DESCRIPTION

Candidate waste retrieval technologies that were available for initial deployment at tank C-108 were (1) modified sluicing, (2) the mobile retrieval system (MRS), (3) modified sluicing with an in-tank vehicle, and (4) the Mobile Arm Retrieval System (MARS) (see Revision 3A of RPP-22393). After considering each candidate waste retrieval technology and designation of the tank as "sound," modified sluicing using recycled double-shell tank (DST) supernate was selected as the initial preferred technology for deployment in tank C-108. Revision 4 of this plan was approved by Ecology on September 4, 2008.

In the modified sluicing deployment, supernate from tank 241-AN-106 (AN-106) was used as the sluicing media to mobilize the waste in tank C-108 and the resulting slurry was pumped to tank AN-106. The slurry from tank C-108 also contained insoluble solid material. The solids settled in tank AN-106 and the supernate was reused in the sluicing operations.

The modified sluicing operation was suspended when DOE determined that the bulk of the remaining waste consisted of solids (hard heel) that were not mobilized by sluicing. At the cessation of modified sluicing, an estimated waste volume of ~6,800 gal (~910 ft^3) remained in tank C-108. In accordance with the general approach provided in Revision 3A of RPP-22393 and Appendix C, Part 1 of the Consent Decree, DOE-ORP considered two second technology alternatives for removing the residual waste after modified sluicing operations. Solid phase characterization results show the presence of two primary constituents: $Al(OH)_3$ (gibbsite) and $Na_7F(PO_4)_2 \cdot 19H_2O$ (natrophosphate [sodium fluoride phosphate]) in an approximate 1:1 ratio (40 wt% gibbsite and 60 wt% natrophosphate) (LAB-RPT-10-00001, *Results of Physicochemical Characterization and Caustic Dissolution Tests on Tank 241-C-108 Heel Solids*). Based on the characterization results, the caustic cleaning process was evaluated and selected as the best available technology due to the primary constituents of the heel waste, gibbsite and phosphate (RPP-PLAN-43858, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Technology Selection*).

[1] See Tank Waste Information Network System (TWINS), Queried 12/19/2006, (Best-basis Inventory, Calculation Detail, Tank 241-C-108, https://twins.pnl.gov/twinsdata/Forms/About.aspx?subject=TWINS).

Prior to initiation of the caustic cleaning process, DOE-ORP determined that one of the sluicers placed in riser R2 in tank C-108 was plugged. The plugging was identified during a leak check on the hose-in-hose transfer line (HIHTL). During the leak test, radiological control personnel monitoring the test noted regions of higher radiation moving through the line, which could have corresponded to "slugs" of waste in the line. This observation suggested that material in the transfer system moved into the sluicer and plugged it during the leak test. Between July 13 and July 17, 2011, three attempts made to unplug the sluicer in riser 2 with water were unsuccessful. After considering the potential increases in worker doses and costs and the potential impacts on the retrieval schedule associated with repairing or replacing the sluicer, a decision was made to move forward with the caustic cleaning process using a single sluicer (RPP-52290, *Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108*).

The chemical cleaning process relies on chemical contact between the waste and the liquid (water or caustic). The caustic cleaning process consists of three main steps which are described in further detail in RPP-RPT-46568, *Tank 241-C-108 Hard Heel Retrieval Flowsheet* and RPP-PLAN-44944, *Process Control Plan for Tank 241-C-108 Waste Heel Retrieval.* The caustic cleaning process is comprised of three steps: a water dissolution step to dissolve natrophosphate, followed by addition of sodium hydroxide to metathesize the gibbsite to sodium aluminate, and finally aluminum dissolution in water for removal. The process steps were based on the analytical results from a tank C-108 post-sluicing sample.

The DOE-ORP added a water sluicing step to the caustic cleaning process for tank C-108 in an effort to retrieve additional solid material. In this additional sluicing step, ~10,000 gal (~1,340 ft^3) of water were added to tank C-108 via the sluicer and concurrently transferred out in an attempt to suspend and remove fine solids from tank C-108. It is estimated that ~522 gal (~70 ft^3) of additional solids were removed by this activity (RPP-CALC-52225, *Waste Volume of Single-Shell Tank 241-C-108 Remaining After Hard Heel Retrieval*).

2.3 RETRIEVAL CAMPAIGN CHRONOLOGY

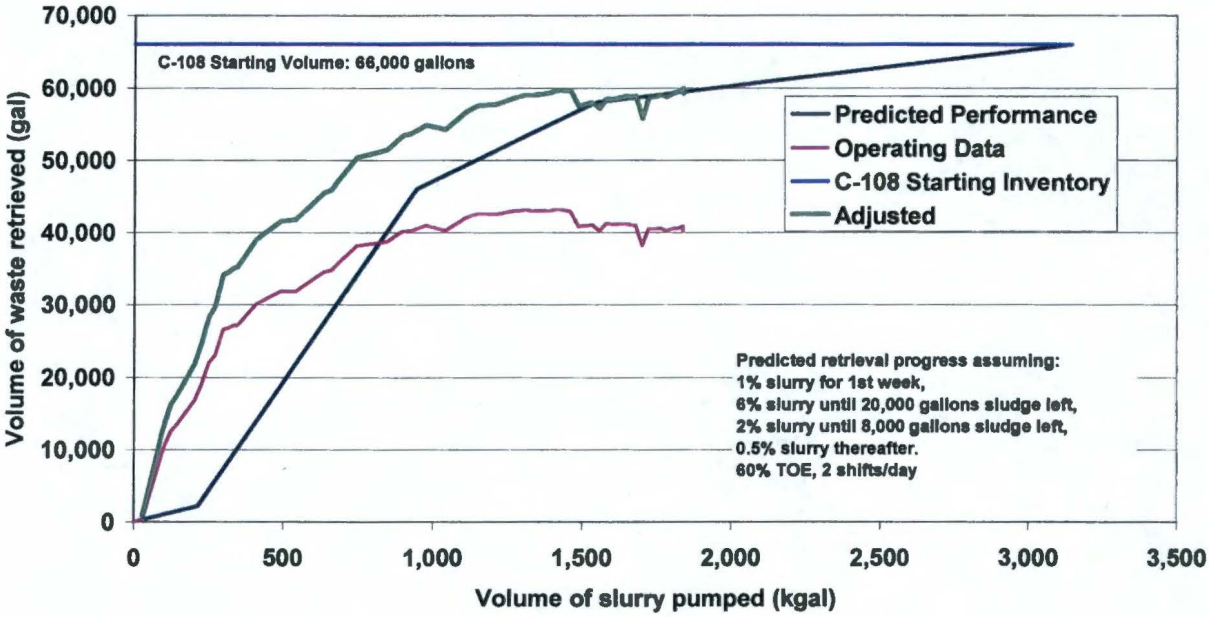
2.3.1 Modified Sluicing

The general chronology for modified sluicing at tank C-108 is described in SVF-1518, *C-108 volume balance 4-27-07.xls*. Modified sluicing operations were performed during 57 operating days (80 shifts) starting on December 20, 2006 and ending on April 27, 2007. By January 11, 2007, most of the soft sludge had been removed. Most of the area under and between the two sluicers had been cleared of solids; in these areas, the tank bottom was either exposed or covered by a relatively thin layer of solids. The sluicers were able to move these solids about the tank, but the solids tended to settle too quickly to be readily entrained and removed by the slurry pump. The bulk of the remaining solids were near the tank knuckle (the section connecting the tank dish and the tank walls) on the east and west sides of the tank furthest from the sluicer installations.

Figure 1 shows retrieval system performance as a function of the volume of slurry (solids plus recycled tank AN-106 supernate) transferred from tank C-108 to tank AN-106. The occasional

decreases in the volume retrieved in Figure 1 reflect fluctuations in the ending tank C-108 liquid pool volume. It was not always possible to pump the tank C-108 liquid pool to the same level at the end of each operating period.

Figure 1. Tank 241-C-108 Modified Sluicing System Performance.



Retrieval system performance was tracked by trending the net waste volume increase in the receiver tank AN-106 after accounting for water additions; this is shown as the Operating Data line in Figure 1. This running volume balance does not distinguish between liquids and solids and does not account for solids dissolution or liquid evaporation. As the volume of waste material received by tank AN-106 approaches the starting waste volume of tank C-108, the estimate of the volume remaining in tank C-108 using the arithmetic difference between these two numbers becomes increasingly sensitive to uncertainties in the starting waste volume estimate and cumulative measurement uncertainties. The running volume balance was subsequently adjusted as described below to generate an estimate of the actual volume of waste retrieved during modified sluicing of tank C-108.

On April 12, 2007, ~25,000 gal (~3,300 ft^3) of supernatant liquid from tank AN-106 were added to tank C-108 to soak the solids. The liquid was added in 5,000-gal increments, and a level measurement was taken following the addition of each increment. The level measurement was obtained using the Enraf[2] instrument located in riser R8. The level measurements in tank AN-106 were also taken before and after each supernate transfer. As the liquid was added to tank C-108, the difference was calculated between the expected rise in the surface level (based on the tank dimensions) and the actual rise in surface level. The actual rise in surface level is affected by the volume of solids remaining in the bottom of the tank. This method allows the volume of the solids that become covered by liquid to be calculated, and is referred to as the

[2] Honeywell Enraf is a product of Honeywell Process Solutions, Strahlenbergerstr. 110-112, 63067 Offenbach, Germany.

"volume displacement method." Details of the calculations are documented in RPP-CALC-33487, *Estimate of Waste Volume and Percent Retrieved for Tank 241-C-108.*

While the 25,000 gal (~3,300 ft^3) of liquid were in tank C-108, video recordings were taken. The videos showed several areas where peaks of waste piles protruded above the liquid level. The liquid level represented a depth of 17.7 in. (above the lowest point in the dish of the tank bottom) as measured by the tank C-108 Honeywell Enraf.

On April 16, 2007, the supernatant liquid was removed from tank C-108 and between April 18 and 27, sluicing was performed for seven more shifts. Very little solid material was recovered during this time, and it was concluded that additional modified sluicing was not warranted.

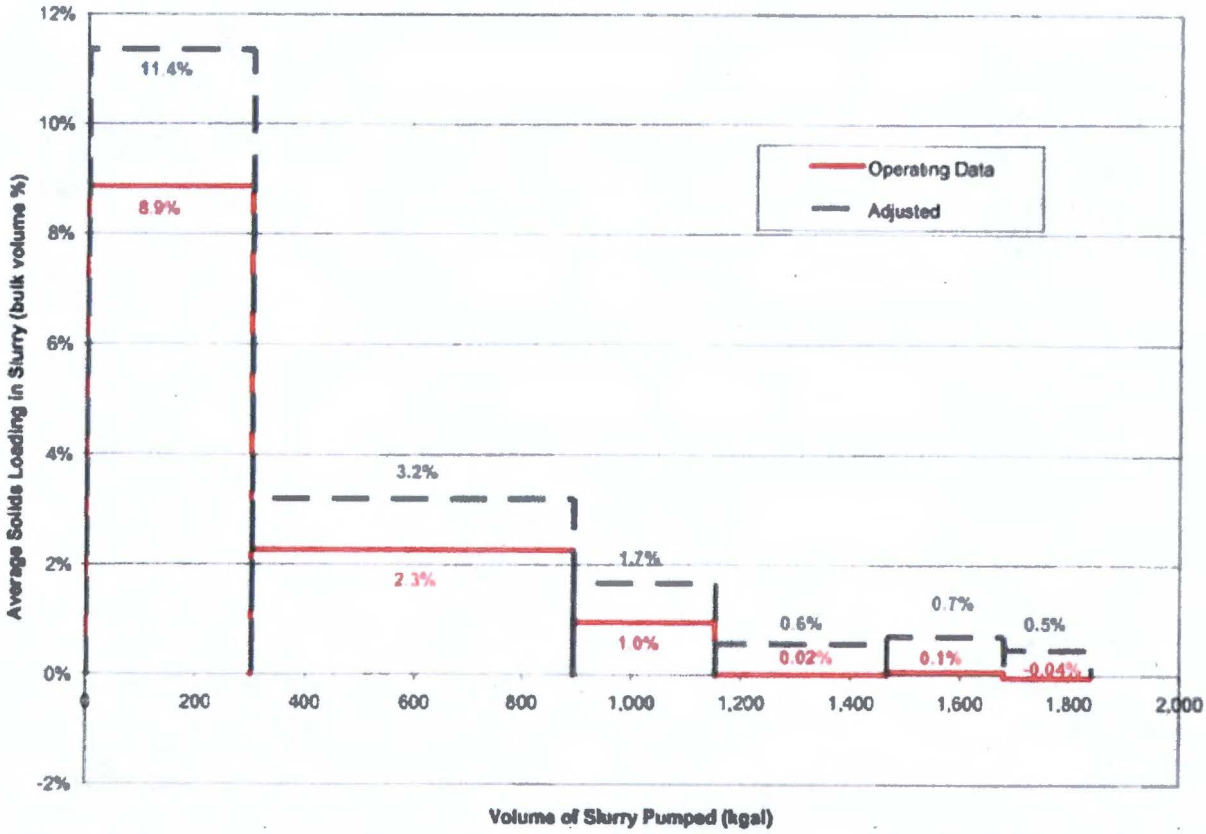
Based on a volume balance using the increase in tank AN-106 liquid level, ~40,000 gal (~5,350 ft^3) of tank C-108 waste were estimated to have been retrieved, leaving ~7,200 gal (~960 ft^3) in tank C-108 as reported in RPP-CALC-33487. This estimate is ~20,000 gal (~2,670 ft^3) less than the volume estimated from the running volume balance (Operating Data line in Figure 1). This difference is attributed to void spaces in the tank C-108 waste, water evaporation and transport through the exhausters, uncertainties in the volume displacement measurements, and uncertainties in the initial volume as established by the BBI. This difference in the BBI waste volume and the actual measured waste removed during retrieval operation reflects the uncertainty in the BBI due to a number of factors that include tank construction tolerances and waste characteristics (layering and retained gas). Waste retrieval performance measures throughout the waste retrieval operation are based on the initial BBI waste volume estimate, and actual waste volumes retrieved from tank C-108.

The line noted as "Adjusted Operating Data" in Figure 1 is an estimate of the actual volume of waste retrieved from tank C-108, after accounting for void spaces in the wastes, water that evaporated during retrieval, and the other factors mentioned in the previous paragraph (i.e., water transport through the exhausters, uncertainties in the volume displacement measurements, and uncertainties in the initial volume as established by the BBI).

Figure 2 shows the trend in retrieval system volumetric efficiency, as measured by the average solids loading in the slurry, as a function of the volume of slurry pumped from tank C-108. At the beginning of retrieval, the modified sluicing process was effective at removing waste out of the tank. The high solids concentration in the slurry showed that the bulk of the waste in the tank was being removed. Retrieval operations progressed until the end of the modified sluicing campaign when most of the waste had been removed.

Material balance data were used to estimate the volume of additional waste retrieved from tank C-108 during the final sluicing operations between April 18 and April 27, 2007. The material balance data were used to evaluate the difference between the volume of liquid used for sluicing and the total volume of material (liquid and solid) transferred out of the tank. This difference indicated that ~400 gal (~53 ft^3) of waste was retrieved from tank C-108 during this period, leaving an estimated waste volume of ~6,800 gal (~910 ft^3) in the tank.

Figure 2. Solids Loading in Tank 241-C-108 Slurry.



A summary of the amount of waste retrieved and waste remaining in tank C-108 after the modified sluicing is provided below in Sections 3.0 and 4.0.

2.3.2 Caustic Cleaning

At the end of bulk retrieval using modified sluicing, the remaining waste was comprised mostly of solids (hard heel) that are not mobilized by sluicing and are insoluble in the tank AN-106 supernate. Samples of the residual waste were obtained and analyzed. Solid phase characterization results show the presence of two primary constituents: gibbsite and natrophosphate in an approximate 1:1 ratio (40 wt% gibbsite and 60 wt% natrophosphate) (LAB-RPT-10-00001).

Because characterization results indicated that the primary constituents of the heel waste were gibbsite and phosphate (RPP-PLAN-43858), the caustic cleaning process was evaluated and selected as the best available technology for further retrieval. Results achieved during laboratory testing (LAB-RPT-10-00001) indicated that the caustic cleaning technology should be capable of achieving the removal of residual heel volumes.

A process flowsheet was developed (RPP-RPT-46568) and caustic cleaning was performed starting on October 13, 2011, and ending on March 22, 2012, reaching the limit of technology at

the end of this retrieval period. In this process, a sodium hydroxide (caustic) solution (50 wt%) was added to tank C-108. The slurry pump and sluicer were used to circulate the sodium hydroxide solution in the tank. As the solids were not completely submerged in the sodium hydroxide solution at onset, the sluicer was used to erode and reduce the solids, to the extent practicable, that were protruding above the surface into the pool. The caustic fluids were further circulated to enable the sodium hydroxide solution to contact the solids. Samples of the liquid were obtained to monitor the metathesis reaction. Sample analyses indicated that the metathesis reaction, in terms of hydroxide consumption, was over 100% of planned consumption based on inventory estimates. Details of these evaluations and supporting analytical data are provided in RPP-RPT-52449, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Completion Report*.

After the metathesis reaction phase, water was added to the tank to dissolve the sodium aluminate formed by the reaction; this water was used to clean the tank wall and provide mixing. The aluminate dissolution liquor was circulated and sampled, then transferred to tank AN-106 using a volumetric displacement procedure to determine the volume of the residual waste. Details of these evaluations are provided in RPP-RPT-52449.

On March 20, 2012, 10,100 gal of water were added to tank C-108 to dissolve sodium aluminate. On March 21, 2012, tank C-108 liquid was circulated for ~15 hours. The amount of water added, and the time allowed between water addition and liquid removal, were determined based on the process tests performed in the laboratory, and on the volume and characteristics of the waste in tank C-108. The dissolution of sodium aluminate in water is expected to occur quickly. The addition of water to the caustic solution lowers the pH, which will lead to re-precipitation of gibbsite over time. Consequently, a limited time period was selected for the aluminate dissolution step.

During the circulation period on March 21, 2012, an additional sample of liquids in the tank was collected and delivered to the laboratory. The purpose of this sampling event was to provide information regarding future application of the caustic cleaning process, rather than to assess the aluminate dissolution step.

During this period, video recordings of the tank interior were obtained and used to evaluate the size of any waste piles that still protruded above the liquid surface level. The black sections in Figure 2-11 of RPP-CALC-52225 represent the approximate size and location of the waste piles that exceeded the liquid level. The liquid level represents a depth of 16.5 in. (above the lowest point in the dish of the tank bottom) as measured by the tank C-108 Honeywell Enraf.

The transfer of liquid from tank C-108 to tank AN-106 was completed on March 22, 2012. Volume displacement measurements and tank video scans were performed during the transfer out. Based on the video evidence, it appeared that the transfer out was successful, and large areas of the tank floor were visible.

A summary of the amount of waste retrieved and waste remaining in tank C-108 after the caustic cleaning process is provided below in Sections 3.0 and 4.0.

2.4 LIMIT OF TECHNOLOGY

2.4.1 Modified Sluicing

According to RPP-50910, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing*, meeting the following two criteria constitutes reaching the "limit of technology" for retrieval of waste from a Hanford Site SST using modified sluicing with only DST supernate or water as the sluicing medium.

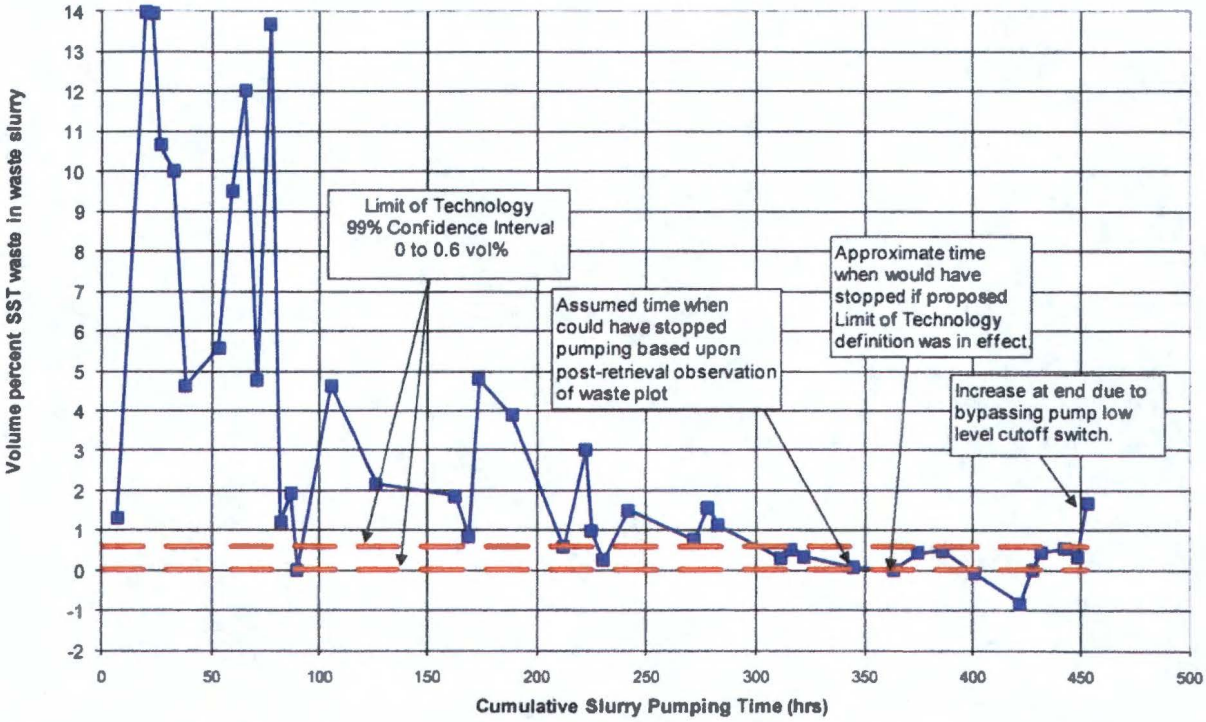
1) The concentration of SST waste in the retrieved slurry sent to the DST is within or bracketing a 0 to 0.6 vol. percent range for three operating periods. Bracketing refers to two successive data points, one of which is below 0 and the next near or above 0.6, which average less than 0.6 vol. percent. An operating period is a period over which retrieval performance is measured. An operating period is normally one operating day, but as a minimum must be greater than or equal to 8 hours in duration and consist of at least ~10,000 gal (~1,340 ft^3) of slurry transferred from the SST.

2) The DOE-ORP and the Tank Operations Contractor have provided documentation to Ecology that demonstrates that all reasonable efforts were attempted to enhance the effectiveness of the installed modified sluicing retrieval system in order to increase waste removal from all quadrants of the tank under consideration.

Per the Consent Decree, during evaluation of the limits of technology related to modified sluicing, DOE-ORP also considered an examination of other factors specified in the Decree including risk reduction, facilitating tank closures, worker safety, and the overall impact on mission and costs. A brief discussion of these factors as they relate to use of modified sluicing is as follows.

- As indicated in Figure 2 above, DOE-ORP showed the trend in retrieval system volumetric efficiency as measured by the average solids loading in the slurry as a function of the volume of slurry pumped from tank C-108. The decline in volumetric efficiency reflects a depletion of readily mobilized sludge in the tank, the difficulty of mobilizing harder sludge, and the increasing distance of remaining solids from the sluicers. The 0.02% solids loading (0.6% adjusted), shown in Figure 2, occurred when the second sluicer located in riser 2 lost mobility; the retrieval efficiency increased only slightly when the sluicer was replaced. The final days of operations show little to no net waste retrieval; this was also supported by visual observations of the retrieval operations. Figure 3, below, shows the concentration of SST waste in the retrieved slurry (volume percent waste in the retrieved slurry) as a function of pumping time. The orange bars show the range of 0 to 0.6 vol. percent that is cited in criterion 1) of the above limit of technology definition. As shown on the graph, the slurry volume percent recovery moved into this range and stayed there for at least 3 operating periods by ~360 hours of pumping time, meeting criterion 1).

Figure 3. Tank 241-C-108 Combined and Filtered[1] Data for Waste Slurry Volume Percent versus Slurry Pumping Time.



[1] "Combined and Filtered" data refers to combination of multiple measurements to consider the amount of free liquid removed, which may vary between operating periods. More detail on the data processing can be found in RPP-50910, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing.*

- The second criterion associated with the limit of technology definition for modified sluicing requires a demonstration that all reasonable attempts were made to enhance the effectiveness of the installed modified sluicing system in order to increase waste removal from all quadrants of the tank under consideration. At the end of modified sluicing in tank C-108, waste had been mobilized and removed from the areas under the sluicers and the center of the tank. Most of the solids that still remained were in the area near the tank walls, between the two sluicers. These observations, coupled with the measured decrease in recovery with continued operation, demonstrate that all reasonable efforts were made to retrieve the waste from all quadrants of the tank.

- The continued deployment of the modified sluicing system would require continued use of work crews, resources, and equipment that DOE-ORP needs to use to retrieve other tanks within Waste Management Area (WMA) C. The small incremental amount of residual wastes that would be removed by continuing modified sluicing would result in an insignificant reduction in risk from residual wastes left in tank C-108 and would result in little or no benefit to facilitating closure of tank C-108 and other tanks and facilities in WMA C.

- Continued modified sluicing would result in continued exposure to workers that is not justified by the minimal amount of waste that could be removed by continuing with modified sluicing efforts. Although sluicing operations are controlled from a control trailer, multiple field activities (valve line-ups, field measurements and monitoring, etc.) are required to support the sluicing operations, resulting in continued exposure.

- Continued deployment of modified sluicing would delay the completion of retrieval activities at tank C-108 with limited benefits. At this point in time, any delay in completion would have the potential to adversely affect schedules of other retrieval activities and therefore impact the ability of the overall retrieval and treatment mission to meet current Consent Decree milestones and commitments.

- Continued use of work crews, resources, and equipment during modified sluicing would incur additional costs with little or no incremental benefit to decreasing risks from residual wastes in tank C-108. These efforts would divert resources from other more pressing retrieval activities associated with un-retrieved tanks and would likely result in an overall increase in costs associated with the retrieval and closure mission.

Based on the performance metrics evaluated with the implementation of this technology and consideration of the factors specified in the Consent Decree, DOE-ORP has concluded that the modified sluicing retrieval technology has been deployed to the limit of technology at tank C-108.

2.4.2 Caustic Cleaning

Specific criteria by which to measure the limit of technology for chemical retrieval processes such as caustic cleaning have not been defined to this point due to the lack of operational experience. The DOE-ORP gained limited previous in-tank experience with caustic dissolution during retrieval of tank 241-S-112 (RPP-RPT-35112, *Retrieval Data Report for Single-Shell Tank 241-S-112*). In that tank, ~4,500 gal (~600 ft^3) of granular waste material remained in the tank at the end of the remote water lance retrieval campaign. Additions of 25 wt% caustic and 50 wt% caustic were performed, followed by sluicing. The caustic treatment resulted in some breakup of the waste particles which allowed them to be retrieved by sluicing. This experience provided confidence that a chemical retrieval process could be effective as a waste retrieval technology, but did not provide sufficient information to define a limit of technology.

From the analytical data on samples of caustic solutions and water used during the caustic cleaning process, and the video evidence that shows waste residuals diminishing in size during the caustic cleaning process, DOE-ORP concluded that the metathesis reaction and dissolution processes associated with caustic cleaning had reached practical limits. The DOE-ORP did not expect significant additional waste removal by repeating these processes in tank C-108.

The DOE-ORP's evaluation of the limits of technology also considered Consent Decree factors related to risk reduction, facilitating tank closures, worker safety, and the overall impact on mission and costs. A brief discussion of these factors as they relate to use of caustic cleaning is as follows.

- All steps in the chemical cleaning process using caustic solutions for tank C-108 were performed as described in the process control plan (RPP-PLAN-44944). Analytical results from samples obtained during the metathesis step confirm that the reactions had consumed the hydroxide and had gone to completion. Results from the caustic solution sampling indicated that more than enough of the reactant was present (i.e., caustic solutions in the metathesis step and water in aluminate dissolution step) to support the objectives of this deployed chemical retrieval process. Systematic efforts were made to contact all areas of the waste with the caustic solutions and/or water. Observation of the operations, discussion with operators, and observance of the waste itself (e.g., reduction of waste piles) confirm that the efforts to contact the caustic solution and the residual wastes were successful. Continued deployment of this chemical retrieval process would not result in appreciably reducing the amount of waste remaining in tank C-108 and therefore the risk from the residual wastes in tank C-108.

- A redeployment of the caustic cleaning process would not make efficient use of work crews, resources, and equipment being used in other areas of WMA C and would interfere with other retrieval efforts. The incremental decrease in amount of residual wastes by redeployment would be very small, would not significantly reduce the associated risk from residual wastes left in tank C-108, and would result in little or no benefit to facilitating closure of tank C-108 and other tanks and facilities in WMA C.

- A redeployment of caustic cleaning would result in continued exposure to workers. Although retrieval operations are controlled from a control trailer, multiple field activities (valve line-ups, field measurements and monitoring, etc.) are required to support the sluicing operations, resulting in continued exposure.

- A redeployment of caustic cleaning would delay the completion of retrieval activities at tank C-108 with limited or no benefit. This delay in completion would have the potential to adversely affect schedules of other retrieval activities and therefore impact the ability of the overall retrieval and treatment mission to meet current Consent Decree milestones and commitments.

- Continued use of work crews, resources, and equipment with a redeployment of caustic cleaning would continue to incur costs with little or no incremental benefit to decreasing risks from residual wastes in tank C-108. These efforts would divert resources from other, more pressing retrieval activities associated with un-retrieved tanks and would likely result in an overall increase in costs associated with the retrieval and closure mission.

Based on the performance metrics examined with the implementation of this technology and consideration of the factors specified in the Consent Decree, DOE-ORP has concluded that the caustic cleaning retrieval technology has been deployed to the limit of technology at tank C-108.

2.5 REQUEST TO FOREGO DEPLOYMENT OF A THIRD RETRIEVAL TECHNOLOGY

Because the estimate of waste residual remaining in tank C-108 (660 ft^3) following the deployment of modified sluicing and chemical cleaning exceeded the Decree volume requirement, DOE submitted to Ecology a request to forego deployment of a third technology that would otherwise be required by the terms of the Decree (see RPP-52290). In the Practicability Evaluation Request, DOE evaluated a set of candidate technologies for hard heel waste retrieval that were reviewed and documented in RPP-RPT-44139, *Hard Heel Waste Retrieval Technology Review and Roadmap*. From this evaluation, a subset of technologies was selected for further consideration that included the potential deployment of three technologies that included:

- Additional Modified Sluicing
- Enhanced Reach Sluicing System, and
- Enhanced Modified Sluicing – used with in-tank vehicle such as a FoldTrack®[3].

Based on the location and configuration of the remaining waste in tank C-108, evaluation of the deployment of these technologies indicated that some portion of the remaining waste could potentially be retrieved by any one of these technologies. However, overall conclusions of the Practicability Evaluation Request also indicate that the incremental reduction in waste volume and the resulting changes in waste inventory and associated risk are relatively small, even if the retrieval operation using a third technology were successful in reaching the Decree volume requirement. The incremental increase in worker exposure, duration of field activities, potential delay in subsequent retrieval activities, and cost, are expected to be similar to those from other hard heel removal operations and are likely to outweigh whatever level of waste removal may result from installation and operation of a third retrieval technology.

3.0 POST-RETRIEVAL CONDITIONS

Several methods (i.e., volume displacement, video observations, and engineering judgment) were used to estimate the waste volume removed and the residual waste volume left after each retrieval phase. A complete discussion of these methods and associated calculations of the estimated waste volume removed from tank C-108 during the two retrieval phases (modified sluicing and caustic cleaning) is documented in RPP-CALC-33487 and RPP-CALC-52225.

The initial BBI volume for tank C-108 was estimated at ~66,000 gal (~8,800 ft^3) at the start of retrieval. The amount of waste remaining in tank C-108 after the first retrieval technology was

[3] The FoldTrack® Mobile Retrieval Tool is manufactured by Non Entry Systems Ltd., UK Patent Application No: 0718573.9.

completed was estimated at ~6,800 gal (~910 ft^3). The amount of wastes remaining after the caustic cleaning process technology followed by final sluicing was estimated to be ~4,900 gal (~660 ft^3). A final tank C-108 waste volume evaluation, based largely on tank videos taken on September 16, 2012, estimated a residual waste volume in tank C-108 of ~3,400 gal (~460 ft^3) (see RPP-CALC-54266, *Post-Hard Heel Retrieval Camera/CAD Modeling System Waste Volume Estimate for Tank 241-C-108*)[4].

4.0 RETRIEVAL COMPLETION SUMMARY AND CONCLUSIONS

At the conclusion of modified sluicing, tank C-108 contained ~6,800 gal (~910 ft^3) of waste (see RPP-CALC-33487, *Estimate of Waste Volume and Percent Retrieved for Tank 241-C-108*). At the conclusion of caustic cleaning and final sluicing retrieval operations, tank C-108 is estimated to contain ~3,400 gal (~460 ft^3) of remaining waste. Because the estimate of waste residual remaining in tank C-108 exceeded the Decree volume requirement, DOE submitted to Ecology a request to forego implementation of a third technology in tank C-108 that would otherwise be required by the terms of the Decree. In the analysis supporting this request (RPP-52290, *Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108*), DOE considered a set of candidate technologies for hard heel waste retrieval that were reviewed and documented in RPP-RPT-44139, *Hard Heel Waste Retrieval Technology Review and Roadmap.*

Based on the analysis performed in the Practicability Evaluation Request (see RPP-52290), DOE concluded that the deployment of any of the selected technologies into tank C-108 is not practicable. Given the configuration of tank C-108 and the remaining residual wastes, the evaluation indicates that while some portion of the remaining waste in tank C-108 may be retrieved by any one of these technologies, the incremental reduction in waste volume and the resulting changes in waste inventory and associated risk are relatively small, even if the retrieval operation using a third technology were successful in reaching the Decree volume requirement. This request by DOE to forego implementing a third retrieval technology in tank C-108 was submitted on September 4, 2012 and was formally approved by Ecology on November 16, 2012 (Letter 12-NWP-178, "Re: Department of Ecology Response to the United States Department of Energy's Letter 12-TF-0037, dated September 4, 2012, and *Practicability Evaluation Request to Forego a Third Retrieval Technology for Tank 241-C-108*, RPP-52290, Rev. 1").

5.0 CONCLUSION

This summary report supports DOE's written certification that DOE has completed retrieval of tank C-108 in accordance with Part 1 of Appendix C of the Consent Decree (*Washington v. DOE*, Case No. 08-5085-FVS [E.D.Wa. October 25, 2010]) and with the retrieval technology/systems that were established by approval of Ecology on May 3, 2012, in Tank Waste Retrieval Work Plan RPP-22393, Revision 6A, and approval of Ecology in

[4] Recent updates of RPP-CALC-54266 provide an estimate of the 95% upper confidence limit for this volume. Details of this calculation will be provided in the final retrieval data report for tank C-108.

12-NWP-178 – Letter on November 16, 2012 to forego a third retrieval technology at tank C-108.

The format and content of this Retrieval Completion Certification summary follows a general outline that was developed collaboratively by Ecology and DOE-ORP in a series of meetings held between December 19, 2011 and March 6, 2012. A working version of this outline was accepted in a February 9, 2012 meeting between DOE-ORP and Ecology.

6.0 REFERENCES

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