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# CALCULATION COVER SHEET

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352,
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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# CALCULATION COVER SHEET

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352,
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30. **Description of Issue/Revision** (Use continuation pages as required)

This report documents the video Camera/CAD Computer Modeling System (CCMS) estimate for the post-hard heel retrieval waste volume in single-shell tank (SST) 241-C-108. The CCMS volume is the official estimate to be included in the tank C-108 Retrieval Data Report and used for tank inventory estimates and risk calculations.

31. **Justification for Issue/Revision** (Use continuation pages as required)

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## LIST OF TERMS

| | |
|---|---|
| CAD | computer-aided design |
| CCMS | (video) Camera/CAD Modeling System |
| HFFACO | *Hanford Federal Facility Agreement and Consent Order* |
| SST | single-shell tank |
| UCL | upper confidence level |

**Units**

| | |
|---|---|
| ft | feet |
| $ft^3$ | cubic feet |
| gal | gallon |
| in. | inch |
| $m^3$ | cubic meters |

**Calculation Checklist**

**Calculation Title/Subject:** **POST-HARD HEEL RETRIEVAL CAMERA/CAD MODELING SYSTEM WASTE VOLUME ESTIMATE FOR TANK 241-C-108**

**Scope of Review:** Entire Document
(e.g., document section or portion of calculation)

**Engineer/Analyst** J. G. Field *JG Field* Date: 1/21/2013
(printed name and signature)

**Organizational Manager:** W. B. Barton *WB Barton* Date: 1-23-2013
(printed name and signature

| Yes | No | NA* | | |
|---|---|---|---|---|
| ☒ | ☐ | ☐ | a. | The objective/purpose of the calculation is clearly stated and the problem is completely defined by the purpose statement. |
| ☒ | ☐ | ☐ | b. | Analytical and technical approaches and results are reasonable and appropriate. |
| ☒ | ☐ | ☐ | c. | Input data are adequately described, referenced to their source, and checked for consistency with original source information. |
| ☒ | ☐ | ☐ | d. | Necessary assumptions are reasonable, explicitly stated, and supported. Assumptions requiring verification prior to use are clearly stated and identified/tracked using TBD/HOLD numbers. |
| ☒ | ☐ | ☐ | e. | For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations. |
| ☒ | ☐ | ☐ | f. | Mathematical derivations were checked, including dimensional consistency of results. |
| ☒ | ☐ | ☐ | g. | Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. |
| ☒ | ☐ | ☐ | h. | Hand and MathCAD© calculations were verified, including review that correct input data are used, formulae correctly interpret intended expressions, correct units are used, and results are reasonable and appropriate. |
| ☒ | ☐ | ☐ | i. | Software applications used are identified by the program name and version/release number, both on the calculation cover sheet and in the body of the document. |
| ☒ | ☐ | ☐ | j. | Software input data is identified and/or attached/included, the input data is correct, and consistent with the calculation document. |
| ☒ | ☐ | ☐ | k. | Software output is consistent with the input and with the results reported in the calculation document. |
| ☒ | ☐ | ☐ | l. | Software verification and validation are addressed adequately in accordance with TFC-BSM-IRM_HS-C-01. Software verification documentation is noted on the calculation cover sheet and in the body of the document as included in the calculation document or a reference is provided to separate verification documentation. |
| ☐ | ☐ | ☒ | m. | Spreadsheets used in the calculation are identified, verified, and documented in accordance with TFC-BSM-IRM_HS-C-01. Reference to the corresponding spreadsheet verification form is provided on the calculation cover sheet and in the body of the calculation. |
| ☒ | ☐ | ☐ | n. | Data or results presented in tables and graphs have been checked against original source. |
| ☒ | ☐ | ☐ | o. | Unit conversions are correct and consistent. |
| ☒ | ☐ | ☐ | p. | The number of significant digits is appropriate and consistent. |
| ☒ | ☐ | ☐ | q. | Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. |
| ☒ | ☐ | ☐ | r. | Conclusions are consistent with analytical results and applicable limits. |
| ☒ | ☐ | ☐ | s. | Results and conclusions address all points in the purpose. |
| ☒ | ☐ | ☐ | t. | Referenced documents are retrievable or otherwise available and the version or revision of each reference is cited. |
| ☒ | ☐ | ☐ | u. | The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions," of TFC-ENG-DESIGN-C-10. |
| ☒ | ☐ | ☐ | v. | Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate. |
| ☒ | ☐ | ☐ | w. | All checker comments have been dispositioned and the design media matches the calculations. |

M. A. Dado *M.A. Dado* 1/22/2013
Checker (printed name and signature) Date

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No" or "NA", an explanation must be provided here or attached: m. No spreadsheets used

## 1.0 OBJECTIVE/PURPOSE

This report documents the video Camera/CAD Computer Modeling System (CCMS) estimate for the post-hard heel retrieval waste volume in single-shell tank (SST) 241-C-108 (C-108). The CCMS volume is the official estimate to be included in the tank C-108 Retrieval Data Report and used for tank inventory estimates and risk calculations in accordance with Appendix I of the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989).

Tank C-108 post-retrieval volumes were previously estimated using Honeywell Enraf (hereafter referred to as Enraf) surface level measurements for liquid displacement estimates and using engineering judgement based on video observations (see RPP-CALC-52225, *Waste Volume of Single-Shell Tank 241-C-108 Remaining after Hard Heel Retrieval*). However, some waste was not submerged after water was added for the final retrieval steps and Enraf displacement provided only a partial estimate of waste in the tank bottom. As a result, a post-retrieval CCMS volume estimate is required per RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives.*

In addition, as noted in RPP-CALC-52225, there are several potential sources of error in the Enraf displacement waste volume estimate. The Enraf displacement estimate appeared to be high compared with in-tank video observations. However, on one side of the tank there was little light and videos were dark. Consequently, the amount of waste remaining in the bottom of tank C-108 could not be estimated from the videos obtained during retrieval and the Enraf displacement values provided the primary basis for preliminary waste volume estimates in the retrieval completion report (RPP-RPT-52449, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Completion Report*). Additional video with better lighting was obtained for the CCMS volume estimates.

The residual tank waste volume estimates include waste in the following four locations:

- Tank bottom
- Void spaces of equipment in the tank
- Stiffener rings
- Tank wall.

This report documents the estimated volume of residual waste for each of the above locations.

## 2.0 BACKGROUND

Tank C-108 is a 530,000-gal SST that is one of twelve 75-ft diameter tanks built in 241-C Tank Farm from 1944 to 1945. On April 27, 2007, tank C-108 was retrieved to the limit of technology using the modified sluicing technology, leaving a remaining waste volume of 910 $ft^3$ (6,800 gal) (Letter CH2M-0603302.4, "Contract Number DE-AC27-99RL14047 – Completion of Performance Based Incentive 3, Revision 2, Fee Bearing Milestone PBI-3.2.a.05, C-108 Completion of Retrieval Operations – Request for Incremental Fee Approval"). The bulk of the

remaining waste was comprised mostly of solids (hard heel) that were not mobilized by sluicing. Solid phase characterization of the hard heel showed the presence of two primary constituents: $Al(OH)_3$ (gibbsite) and $Na_7F(PO_4)_2 \cdot 19H_2O$ (natrophosphate), in an approximate ratio of 40 wt% gibbsite to 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 to remove the remaining hard heel (RPP-PLAN-43858, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Technology Selection*).

Retrieval of the tank C-108 hard heel was conducted between October 13, 2011 and March 22, 2012. The tank retrieval was declared complete at the limit of technology on March 22, 2012 with a preliminary volume estimate of 658 $ft^3$ (4,924 gal) of waste remaining based on Enraf displacement and tank video estimates.

# 3.0 VOLUME ESTIMATES

## 3.1 SUMMARY OF RESULTS

The total CCMS volume of post-retrieval residual waste in tank C-108 and the waste volumes associated with the various waste components are given in Table 3-1. The best estimate for the total post-retrieval waste volume in SST C-108 is 397 $ft^3$ with a 95% upper confidence level (UCL) of 457 $ft^3$.

**Table 3-1. Tank 241-C-108 Total Waste Volume and Component Waste Volumes.**

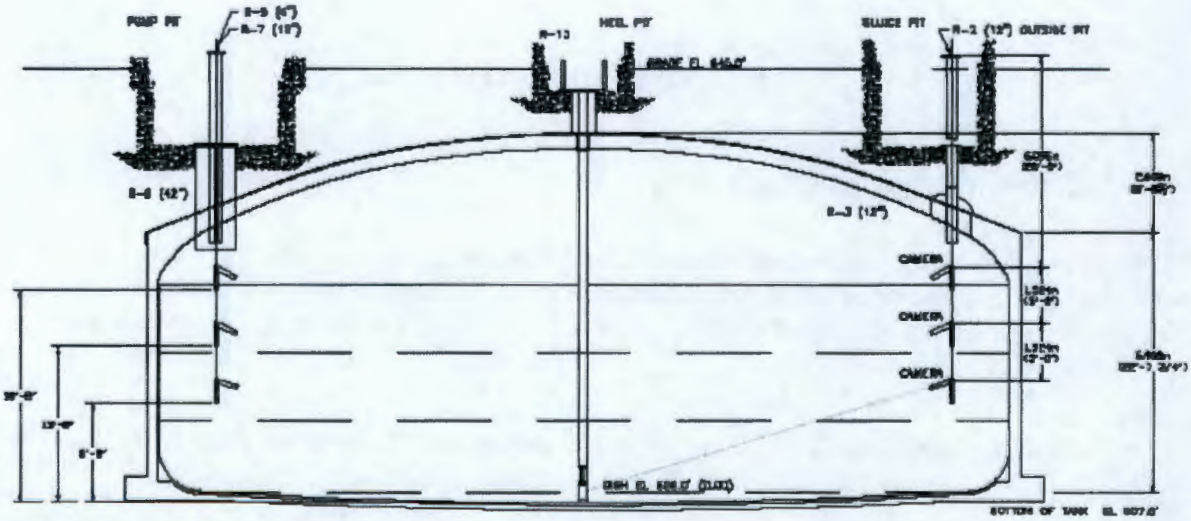
| Component | Waste volume | | | 95% UCL[1] ($ft^3$) |
|---|---|---|---|---|
| | $m^3$ | gal | $ft^3$ | |
| In the bottom (dish) of the tank (solids and liquids) | 8.63 | 2,280 | 305 | 365 |
| Waste in tank equipment [2] | 0 | 0 | 0 | 0 |
| On the stiffener ring[3] | 1.43 | 379 | 50.6 | 50.6 |
| On the tank wall[3] | 1.17 | 309 | 41.3 | 41.3 |
| Total[4] | 11.2 | 2,968 | 397 | 457 |

Notes:
1 $ft^3$ = 7.481 gal, 1 $m^3$ = 264.2 gal, UCL = upper confidence limit
[1] Per RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*, the estimated CCMS error is calculated using: Volume at 95% upper confidence level = 1.195 * CCMS reading + 0.27 ft3
[2] Negligible compared to other waste components.
[3] The estimated volume for waste on the stiffener ring and on the tank wall is the upper bounding estimate.
[4] Total may not equal sum of individual volumes because of rounding.

## 3.2 WASTE ON THE TANK BOTTOM

The post-hard heel retrieval waste volume in the bottom of tank C-108 was estimated using the CCMS method per TFC-ENG-FACSUP-CD-22, "Post-Retrieval Tank Waste Volume Determination." The CCMS videos of tank C-108 were taken on September 16, 2012 from cameras located in riser 3 and riser 8 and video was recorded at heights of ~8 ft, 13 ft, and 18 ft above the bottom of the tank (Figure 3-1). Appendix A shows the instructions that were provided to operators for obtaining the CCMS videos. The instructions were attached with operating procedure TO-220-110, "Over-Ground Transfer from 241-C-108 to 241-AN-106 and Recirculation of Tank 241-C-108."

**Figure 3-1. Section View Showing Camera Elevations Used in Recordings on September 16, 2012.**



After the CCMS video was completed, the video was reviewed to develop an AutoCAD Civil 3D[1] drawing of tank C-108 and the tank waste residuals (H-14-109829, *CCMS Residual Waste Surface Volume Tank 241-C-108*) and to complete tank bottom volume estimates per TFC-ENG-FACSUP-CD-22. The AutoCAD Civil 3D, 2011 software was tested and verified per RPP-52784, Video Camera/CAD Modeling System for Retrieval: HISI #3254 Software Management Plan. Results are shown in Appendix B.

A template of the 100-series 241-C Farm tanks (Figures B-1 and B-2) was developed from tank construction drawings (BPF-73550, *Specifications for Construction of Composite Storage Tanks Bldg. No. 241 Hanford Engineer Works Project 9536*, Drawing D-3). The area and depth of waste and equipment in the tank bottom was estimated based on tank features and the dimensions of equipment and debris observed in the CCMS video (Figures B-3 to B-15 show selected still photographs taken from the CCMS videos). The waste contour information was then added to the template drawing to show waste remaining in the tank bottom (Figures B-16

[1] AutoCAD Civil 3D is a product of Autodesk, Inc., 111 McInnis Parkway, San Rafael, California.

and B-17). After completing the drawings, the AutoCAD Civil 3D software calculated a waste volume by integrating between the waste contour lines and the tank bottom profile.

The estimated volume of waste on the tank bottom, calculated using AutoCAD Civil 3D, was 304.7 $ft^3$. The waste volume consists of an estimated 279 $ft^3$ (7.902×35.31 $ft^3/m^3$) of solids piles and a 25.7-$ft^3$ (0.727×35.31 $ft^3/m^3$) pool of liquids and submerged solids near the center of the tank (Table 3-2). The shape of the pool, not round and off-centered (Figures B-16 and B-17), indicates that the shape of the tank dish is not the same as in the tank template drawing. This was taken into account in estimating the depth of waste at different locations in the tank.

**Table 3-2. 241-C-108 Tank Bottom Camera/CAD Modeling System Waste Volume Estimates**

C-108 POST-RETRIEVAL WASTE VOLUME TABLE: Unadjusted

| Site | Stratum | Surf1 | Surf2 | Cut cu.m. | Fill cu.m. | Net cu.m. | Method |
|---|---|---|---|---|---|---|---|
| SolC108I | SolidsVI | tank dish knuckle | SP-1 | 0.000 | 7.902 | 7.902 (F) | Grid |
| POST-RETRIEVAL SOLIDS: | | | | | | 7.902 (F) | Average |
| LiqC108 | LiquidsVI | tank dish knuckle | pool | 0.000 | 0.727 | 0.727 (F) | Grid |
| POST-RETRIEVAL LIQUIDS: | | | | | | 0.727 (F) | Average |

## 3.3 WASTE IN TANK EQUIPMENT

Per RPP-23403, tank waste remaining in equipment is included in the total waste volume; but the tank equipment is not included. A few small pipes, a steel tape and the off-riser sampler are observed in the tank video. Although the pipes may be full of waste and some waste is observed on the off-riser sampler, the volume of equipment, and the volume of waste potentially remaining in residual equipment in tank C-108 is negligible compared to the volume of waste in the tank bottom, on the stiffener rings and on the walls. Therefore, no waste volume is assigned to the tank equipment.

## 3.4 WASTE ON STIFFENER RINGS

After bulk retrieval, the estimated volume of waste on the stiffener rings was 61.0 $ft^3$ (456 gal) (RPP-CALC-33487, *Estimate of Waste Volume and Percent Retrieved for Single-Shell Tank 241-C-108*). This was estimated based on the surface area of four sets of stiffener rings located at 4.5-ft intervals from the top of the tank dish and the average depth of waste on the

rings at each level. The surface area of each set of stiffener rings was 97.6 $ft^2$. The average estimated depth of waste on the stiffener rings was: no waste on the top ring (ring #1), 0.5 in. on ring #2, 3 in. on ring #3 and 4 in. on ring #4 (closest to the tank bottom).

No measurable waste was removed from the stiffener rings during hard heel retrieval. However, the waste volume estimate of 61 $ft^3$ is high because it includes not only the solid waste volume, but also the volume of voids in the waste. Assuming a drainable porosity value of 0.17 (HNF-2978, *Updated Pumpable Liquid Volume Estimates and Jet Pump Durations for Interim Stabilizations of Remaining Single-Shell Tanks*), the estimated volume of waste on the stiffener rings = 61.0 $ft^3 \times (1 - 0.17)$ = 50.6 $ft^3$ (379 gal).

### 3.5 WASTE ON THE TANK WALLS

After bulk retrieval, the estimated volume of waste on the tank walls was 372 gal (RPP-CALC-33487). This was based on multiplying the surface area of the walls between each of the stiffener rings by the average depth of waste on the walls. No waste was present above the top stiffener ring (ring #1) on the tank wall. The waste between stiffener rings #1 and #2 was estimated to be 1/16 inch. The waste between stiffener rings #2 and #3 was 1/8 in. and the waste between stiffener rings #3 and #4 was about 3/8 inch. Except for bottom waste piles, no waste was observed on the walls below stiffener ring #4 in the knuckle region of the tank.

As for the stiffener rings, no additional waste was removed from the tank walls during hard heel retrieval. Adjusting the volume of 372 gal to account for void spaces in the waste, the estimated volume of waste on the walls is 372 gal $\times (1 - 0.17)$ = 309 gal (41.3 $ft^3$) at a drainable porosity of 0.17.

## 4.0 CONCLUSIONS

The best estimate for the total residual waste volume in SST C-108 is 397 $ft^3$. In accordance with RPP-23403, the total volume using the 95% UCL for the waste on the tank bottom is 457 $ft^3$.

## 5.0 REFERENCES

BPF-73550, 1944, *Specifications For Construction of Composite Storage Tanks Bldg. No. 241 Hanford Engineer Works Project 9536*, Drawing D-3, Rev. 2, Richland, Washington.

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

H-14-109829, 2013, *CCMS Residual Waste Surface Volume Tank 241-C-108*, U.S. Department of Energy, Office of River Protection, Richland, Washington.

HNF-2978, 2003, *Updated Pumpable Liquid Volume Estimates and Jet Pump Durations for Interim Stabilizations of Remaining Single-Shell Tanks*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

LAB-RPT-10-00001, 2010, *Results of Physicochemical Characterization and Caustic Dissolution Tests on Tank 241-C-108 Heel Solids*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

Letter CH2M-0603302.4, "Contract Number DE-AC27-99RL14047 – Completion of Performance Based Incentive 3, Revision 2, Fee Bearing Milestone PBI-3.2.a.05, C-108 Completion of Retrieval Operations – Request for Incremental Fee Approval", (letter from D. B. Cartmell to C. B. Reid [DOE-ORP], June 24), CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23403, 2009, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 4, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-33487, 2007, *Estimate of Waste Volume and Percent Retrieved for Single-Shell Tank 241-C-108*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-CALC-52225, 2012, *Waste Volume of Single-Shell Tank 241-C-108 Remaining after Hard Heel Retrieval*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-52784, 2012, *Video Camera/CAD Modeling System for Retrieval: HISI #3254 Software Management Plan*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-PLAN-43858, 2009, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Technology Selection*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-52449, 2012, *Single-Shell Tank 241-C-108 Hard Heel Retrieval Completion Report*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

TFC-ENG-FACSUP-CD-22, Rev. B-3, "Post-Retrieval Tank Waste Volume Determination," Washington River Protection Solutions, LLC, Richland, Washington.

TO-220-110, Rev, B-16, "Over-Ground Transfer from 241-C-108 to 241-AN-106 and Recirculation of Tank 241-C-108," Washington River Protection Solutions, LLC, Richland, Washington.

# APPENDIX A

# POST-RETRIEVAL TANK WASTE VIDEO GENERAL INSTRUCTIONS

## POST-RETRIEVAL TANK WASTE VIDEO GENERAL INSTRUCTIONS

### Scope

This document provides a general set of instructions and goals for performing the post-retrieval tank waste video scans to support final volume determinations.

### Specific Instructions for Post-Retrieval Tank Waste Video

1. Contact process engineer, final volume modeler, or system engineer to assist in video.
2. Raise and/or lower the camera(s) in order to perform this step at three different camera heights at approximately 8 ft, 13 ft, and 18 ft above tank bottom.
3. Record camera heights and times for each video recording on data sheet 1.

Note: the following scans/crawler steps may be completed in any order and at any time.

4. At each level specified above, record video of tank waste surface, using both cameras.
5. Capture the entire tank without changing focal length (zoom) by beginning with the camera straight down, move straight up to a 90 degree angle (looking straight across the tank), rotate approximately 15 degrees to the left or right, scanning all the way back down, scan all the way back up, rotate another 15 degrees, and repeat the process until the entire tank is captured. Key is to not change the focal length.
6. Scan the entire waste surface.
   A. Zoom on waste piles, mounds, etc.
7. Scan the entire tank floor.
   A. Perform close-ups of in-tank features that may help in determining waste volume and dimensions (height of liquids on the slurry pump screen, weld lines on bottom of tank and knuckle, equipment on the tank floor or in tank waste, etc.).
   B. Focus on the tank weld lines. These lines help a lot, so any visible lines should be focused on with multiple cameras/angles.
   C. Focus on equipment (pipes, pumps, screens, etc.) in the tank waste or on the tank floor that may contain waste.

8. Scan the tank walls.
   A. Zoom on any waste accumulation on the walls.
   B. Scan the entire circumference of each tank stiffener ring, the entire circumference of the knuckle, and the entire circumference of the point where the dish meets the knuckle if visible.
   C. Scan of solids along the tank wall/knuckle showing the height of the waste in relation to the stiffener ring or other tank features.

Note: Use any in-tank equipment or tools to aid with the video (Example: a sampling tool such as the crawler may be used/operated while the cameras are focused on the tool and waste surrounding the tool). The following step may be N/A'd if a crawler is not available.

9. Contact operations to use crawler/sampler to scoop waste, move it around, drive the crawler around, etc. in order to aid with estimating the size and depth of waste piles.

# APPENDIX B

## CCMS ESTIMATE FOR 241-C-108 TANK BOTTOM RESIDUAL WASTE

**Figure B-1. CCMS Surface Volume Template 100-Series Tanks**

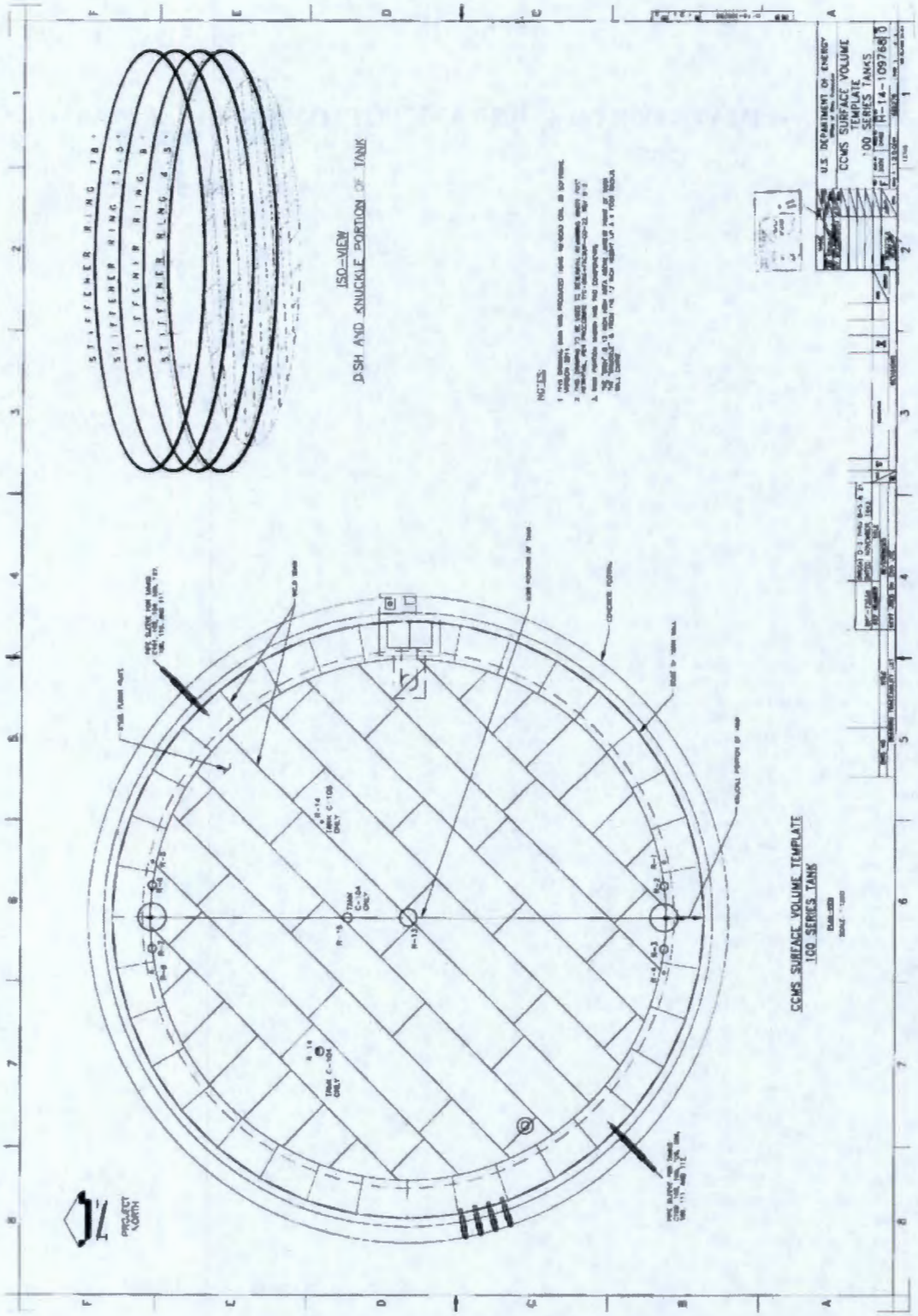
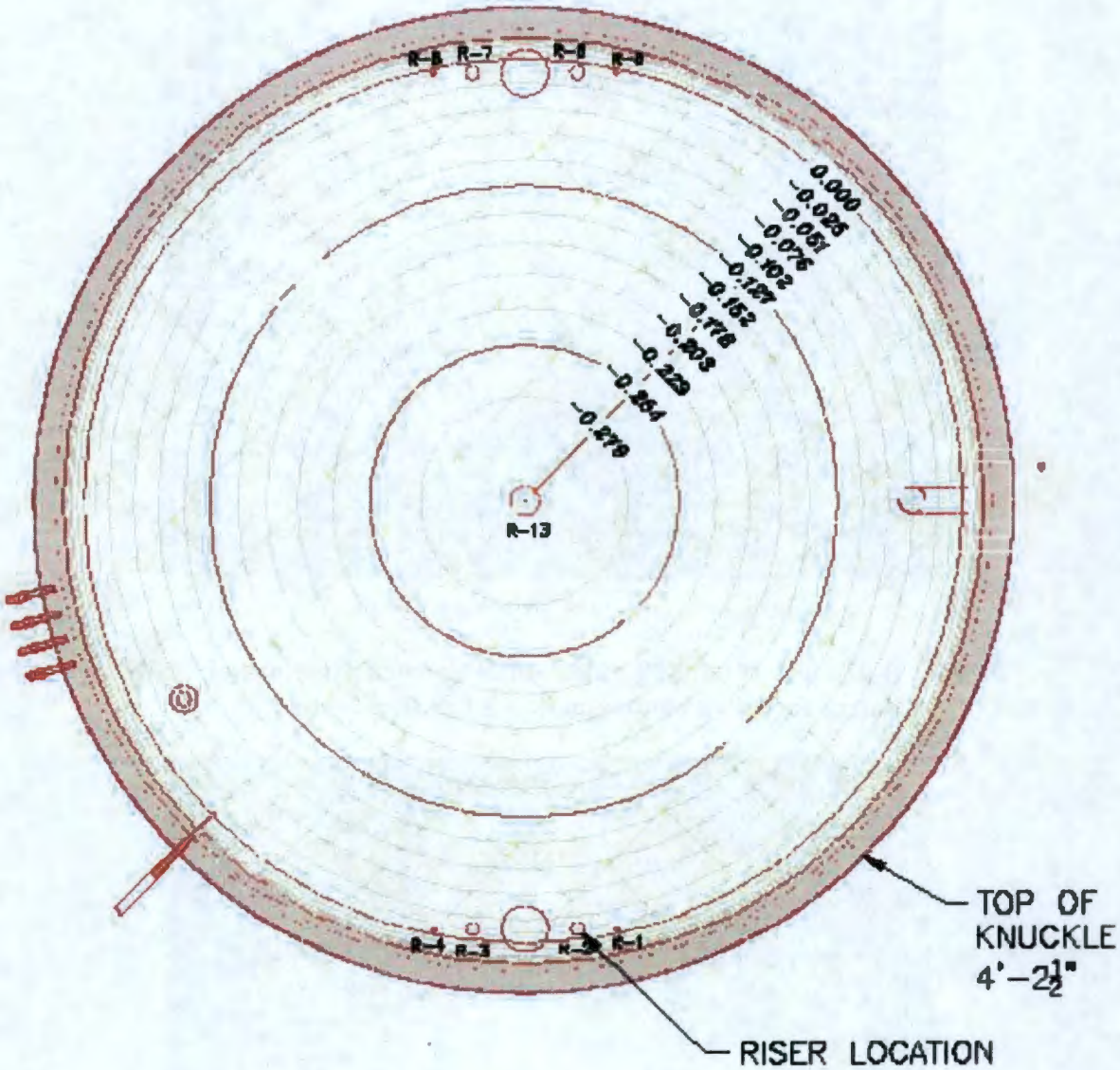


**Figure B-2. Tank 241-C-108, AutoCAD Civil 3D 2011, Rev. 2, Tank Dish Contour Map.**




Reference: H-14-109768, *CCMS Surface Volume Template 100 Series Tanks.*

**Figure B-3. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

Waste appears to be peeling away from bottom Stiffener Ring.

**Figure B-4. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

The waste pile SP 2 continuing along the tank bottom from the original O.R.S.S location. Approximately 10-12 inches high in the middle.

**Figure B-5. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

Bottom of the pump. The liquid level is approximately 2 inches. It is assumed that the screen portion is approximately 1/2 inch above the tank bottom, and the screen is 3 inches high.

**Figure B-6. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

This is assumed to be salt build up at the bottom of Riser 2, approximately 2-3 inches.

**Figure B-7. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

Original O.R.S.S. located to the left of Riser 4 on the beginning of the tank knuckle.

**Figure B-8. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

The waste pile SP-5 continuing along the tank bottom from Riser 3. Approximately 1-2 inches high in the middle.

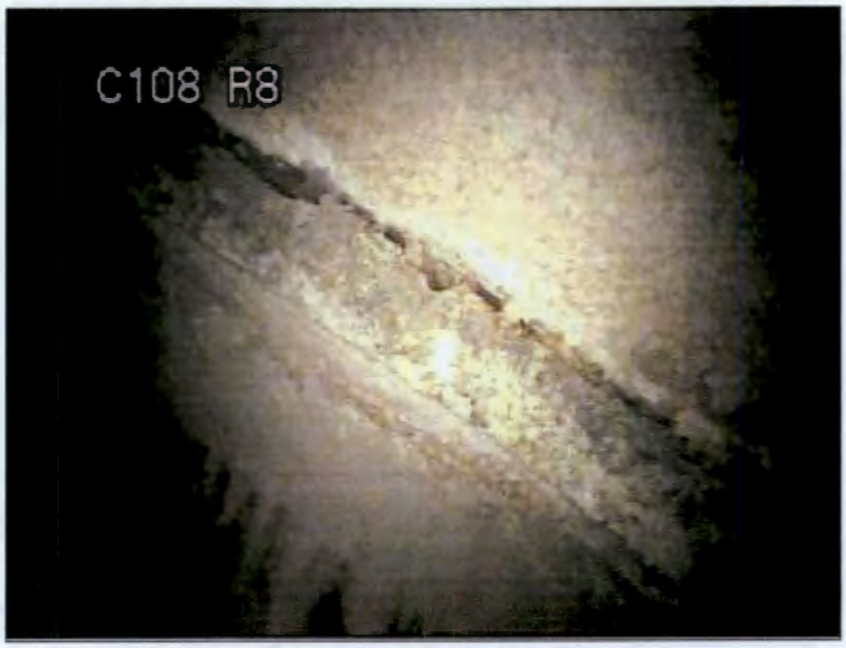
**Figure B-9. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

The O.R.S.S. located N.E. of Riser 3. The dark area in front of the crawler is a approximately 1 3 inch cliff where liquid made a cut through the waste while sluicing.

**Figure B-10. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

The O.R.S.S. next to SP 2 to illustrate the height of the pile.

**Figure B-11. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**




Stiffener Ring and wall immediately above the knuckle portion of the tank shows compacted waste.

**Figure B-12. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

Reflection of waste near the pump at center of tank.

**Figure B-13. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

O.R.S.S. stuck in waste approximate 1- 1.5 inches thick waste, very moist surface.

**Figure B-14. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

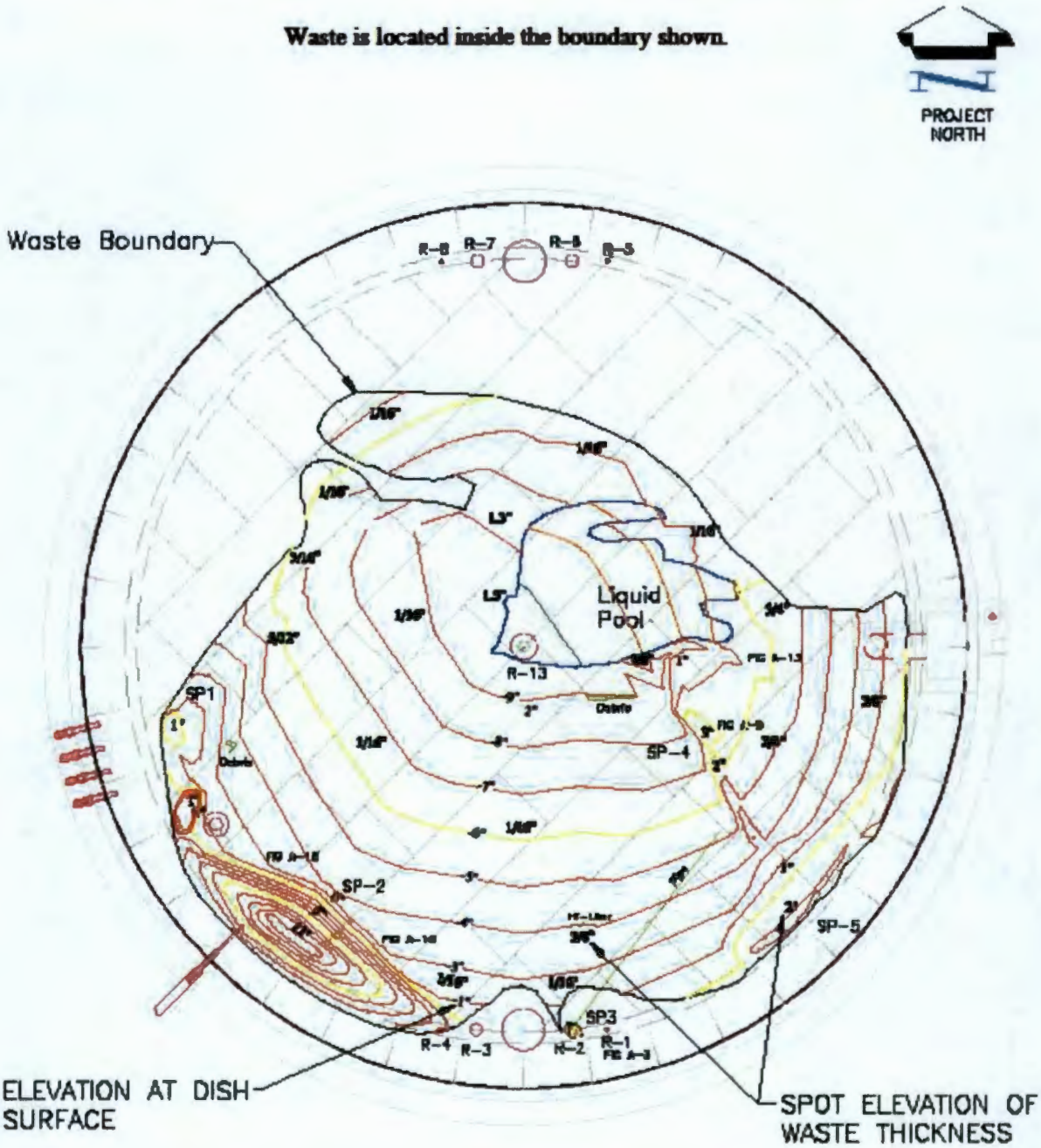
Panoramic view of SP 2 lighted by O.R.S.S.

**Figure B-15. Tank 241-C-108 Video Still, Recorded September 16, 2012, Camera Elevation Approximately 8 feet from Tank Bottom.**

O.R.S.S. next to SP 2 to show pile height.

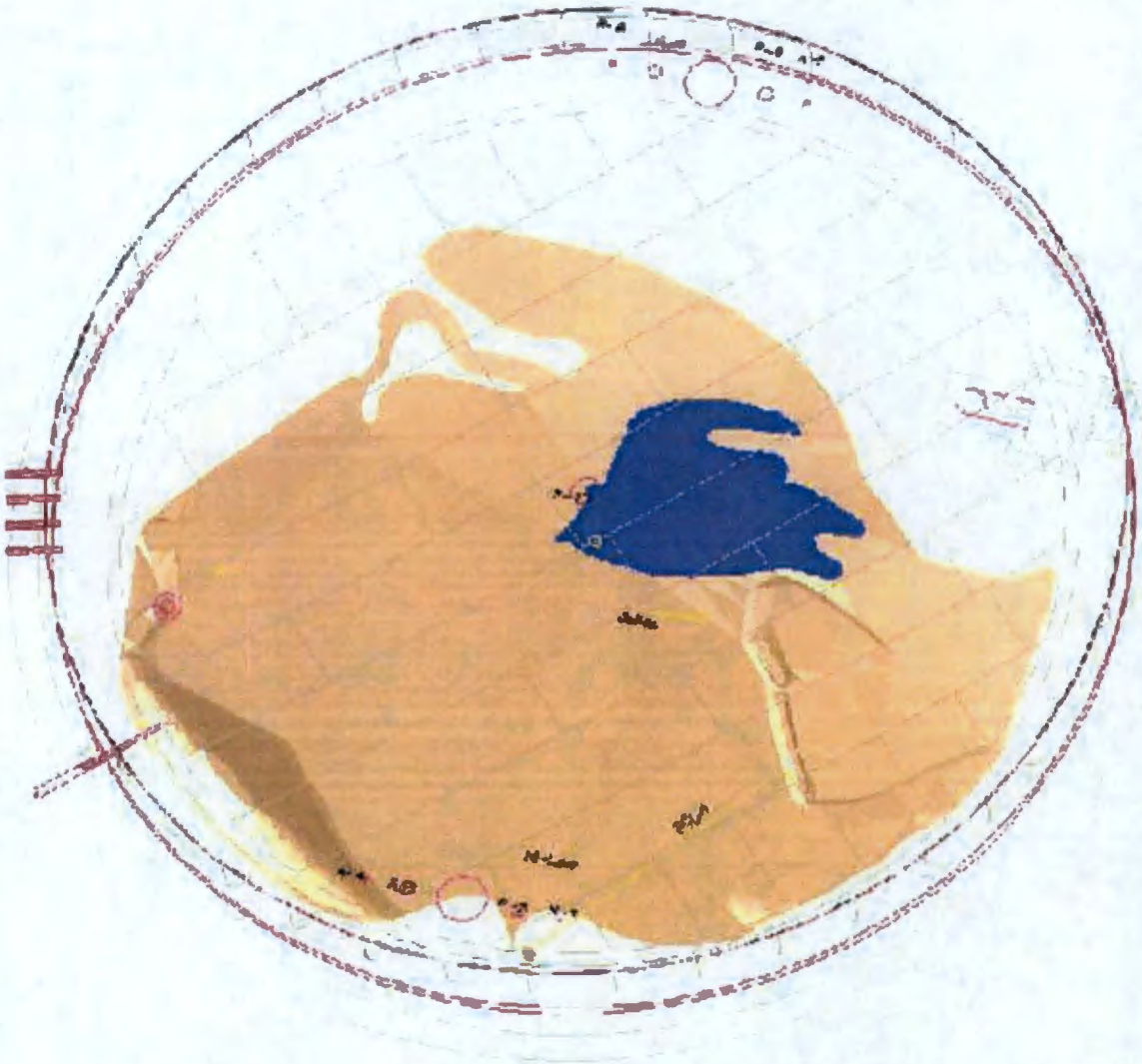
**Figure B-16. Tank 241-C-108, AutoCAD Civil 3D 2011, Rev. 2, Post-Hard Heel Retrieval Tank Waste Volume, Contour Map.**

**Waste is located inside the boundary shown.**




Reference: H-14-109829, *CCMS Residual Waste Surface Volume Tank 241-C-108.*

**Figure B-17. Tank 241-C-108, AutoCAD Civil 3D 2011, Rev. 2, Post-Hard Heel Retrieval Tank Waste Volume, Rendered Isometric View.**



Reference: H-14-109829, *CCMS Residual Waste Surface Volume Tank 241-C-108.*

## Table B-1. Tank 241-C-108, AutoCAD Civil 3D 2011, Rev. 2, Post-Hard Heel Retrieval Tank Waste Volume

C-108 Post-Retrieval Tank Waste Volume Table: Unadjusted

| Base Surface | Comparison Surface | Cut | Fill | Net | Cut Factor | Fill Factor | Cut (adjusted) | Fill (adjusted) | Net (adjusted) |
|---|---|---|---|---|---|---|---|---|---|
| SOLIDS: | | | | | | | | | |
| 1 tank dish knuckle | SP-1 | 0.000 Cu. M. | 7.902 Cu. M. | 7.902 Cu. M.<Fill> | 1.000 | 1.000 | 0.000 Cu. M. | 7.902 Cu. M. | 7.902 Cu. M.<Fill> |
| | | | | | | | | Total: | 7.902 Cu. M. |
| LIQUIDS: | | | | | | | | | |
| 3 tank dish knuckle | pool | 0.000 Cu. M. | 0.727 Cu. M. | 0.727 Cu. M.<Fill> | 1.000 | 1.000 | 0.000 Cu. M. | 0.727 Cu. M. | 0.727 Cu. M.<Fill> |

C-108 POST-RETRIEVAL WASTE VOLUME TABLE: Unadjusted

| Site | Stratum | Surf1 | Surf2 | Cut cu.m. | Fill cu.m. | Net cu.m. | Method |
|---|---|---|---|---|---|---|---|
| SolC108I | SolidsVI | tank dish knuckle | SP-1 | 0.000 | 7.902 | 7.902 (F) | Grid |
| POST-RETRIEVAL SOLIDS: | | | | | | 7.902 (F) | Average |
| LiqC108 | LiquidsVI | tank dish knuckle | pool | 0.000 | 0.727 | 0.727 (F) | Grid |
| POST-RETRIEVAL LIQUIDS: | | | | | | 0.727 (F) | Average |

AutoCAD Civil 3D 2011, Ver 2, VOLUME ESTIMATE
Based on 09/16/2012 Video Recording at C-Tank Farm

VIDEO TAPE No. R3 AND R8
VOLUME CONVERSION TABLE FOR C-108 CAMERA/CAD MODELING SYSTEM (CCMS) RESULTS:

| Description: | Cubic Meters: | Cubic Feet: | Gallons: |
|---|---|---|---|
| TANK SOLID PILE #1 (combines SP-1 thru SP-5) | 7.902 | 279.019 | 2088 |
| TANK WALL (RESIDUAL WASTE) (REF:RPP-CALC-33487) | 1.408 | 49.72 | 372 |
| STIFFENER RINGS (RESIDUAL WASTE) (REF:RPP-CALC-33487) | 1.435 | 50.6 | 379 |
| TANK TOTAL SOLIDS: | 10.745 | 379.339 | 2839 |
| TANK BOTTOM (FLOOR) TOTAL POOL LIQUIDS: | 0.727 | 25.67 | 192 |

Note: Stiffener ring and tank wall volume estimates shown are not adjusted for porosity.

## REFERENCES

H-14-109768, 2012, *CCMS Surface Volume Template 100 Series Tanks*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

H-14-109829, 2013, *CCMS Residual Waste Surface Volume Tank 241-C-108*, U.S. Department of Energy, Office of River Protection, Richland, Washington.