0049960

# ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 638285

Proj. ECN

| 2. ECN Category (mark one) | 3. Originator's Name, Organization, MSIN, and Telephone No. | 4. USQ Required? | 5. Date |
|---|---|---|---|
| Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void [] | B. A. Higley, LMHC, H5-27 376-5694 | [] Yes [X] No | 7/28/97 |
| | 6. Project Title/No./Work Order No. | 7. Bldg./Sys./Fac. No. | 8. Approval Designator |
| | Tank 241-U-105 | NA | NA |
| | 9. Document Numbers Changed by this ECN (includes sheet no. and rev.) | 10. Related ECN No(s). | 11. Related PO No. |
| | WHC-SD-WM-ER-617, Rev. 0 | NA | NA |

| 12a. Modification Work | 12b. Work Package No. | 12c. Modification Work Complete | 12d. Restored to Original Condition (Temp. or Standby ECN only) |
|---|---|---|---|
| [] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d) | NA | NA<br>Design Authority/Cog. Engineer Signature & Date | NA<br>Design Authority/Cog. Engineer Signature & Date |

13a. Description of Change 13b. Design Baseline Document? [] Yes [X] No

Add Appendix D, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-U-105.

RECEIVED EDMC NOV 1998

14a. Justification (mark one)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Criteria Change | [] | Design Improvement | [] | Environmental | [] | Facility Deactivation | [] |
| As-Found | [X] | Facilitate Const | [] | Const. Error/Omission | [] | Design Error/Omission | [] |

14b. Justification Details

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-U-105 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

15. Distribution (include name, MSIN, and no. of copies)

| | | | |
|---|---|---|---|
| Central Files | A3-88 | K. M. Hall | R2-12 |
| DOE Reading Room | H2-53 | K. M. Hodgson | R2-11 |
| TCSRC | R1-10 | T. M. Brown | R2-12 |
| File | H5-49 | B. A. Higley | H5-27 |
| M. J. Kupfer | H5-49 | | |
| M. D. LeClair (3) | H0-50 | | |

RELEASE STAMP

DATE: AUG 25 1997
STA: 34
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A-7900-013-2 (05/96) GEF095

# ENGINEERING CHANGE NOTICE



1. ECN (use no. from pg. 1) 638285

| 16. Design Verification Required | 17. Cost Impact — ENGINEERING | | 17. Cost Impact — CONSTRUCTION | | 18. Schedule Impact (days) | |
|---|---|---|---|---|---|---|
| [] Yes | Additional | [] $ | Additional | [] $ | Improvement | [] |
| [X] No | Savings | [] $ | Savings | [] $ | Delay | [] |

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

| | | | | | |
|---|---|---|---|---|---|
| SDD/DD | [] | Seismic/Stress Analysis | [] | Tank Calibration Manual | [] |
| Functional Design Criteria | [] | Stress/Design Report | [] | Health Physics Procedure | [] |
| Operating Specification | [] | Interface Control Drawing | [] | Spares Multiple Unit Listing | [] |
| Criticality Specification | [] | Calibration Procedure | [] | Test Procedures/Specification | [] |
| Conceptual Design Report | [] | Installation Procedure | [] | Component Index | [] |
| Equipment Spec. | [] | Maintenance Procedure | [] | ASME Coded Item | [] |
| Const. Spec. | [] | Engineering Procedure | [] | Human Factor Consideration | [] |
| Procurement Spec. | [] | Operating Instruction | [] | Computer Software | [] |
| Vendor Information | [] | Operating Procedure | [] | Electric Circuit Schedule | [] |
| OM Manual | [] | Operational Safety Requirement | [] | ICRS Procedure | [] |
| FSAR/SAR | [] | IEFD Drawing | [] | Process Control Manual/Plan | [] |
| Safety Equipment List | [] | Cell Arrangement Drawing | [] | Process Flow Chart | [] |
| Radiation Work Permit | [] | Essential Material Specification | [] | Purchase Requisition | [] |
| Environmental Impact Statement | [] | Fac. Proc. Samp. Schedule | [] | Tickler File | [] |
| Environmental Report | [] | Inspection Plan | [] | | [] |
| Environmental Permit | [] | Inventory Adjustment Request | [] | | [] |

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

| Document Number/Revision | Document Number/Revision | Document Number Revision |
|---|---|---|
| NA | | |

21. Approvals

| | Signature | Date | | Signature | Date |
|---|---|---|---|---|---|
| Design Authority | | | Design Agent | | |
| Cog. Eng. M. J. Kupfer | [signature] | 8-14-97 | PE | | |
| Cog. Mgr. K. M. Hodgson | [signature] | 8-14-97 | QA | | |
| QA | | | Safety | | |
| Safety | | | Design | | |
| Environ. | | | Environ. | | |
| Other T. M. Brown | [signature] | 8/14/97 | Other | | |

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

# Tank Characterization Report for Single-Shell Tank 241-U-105

**B. A. Higley**
Lockheed Martin Hanford Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 638285 UC: 712
Org Code: 74610 KN Charge Code: N4G3A
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Key Words: TCR, best-basis inventory

Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-U-105 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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Karen L. Noland 8/25/97
Release Approval Date

AUG 25 1997
DATE:
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Release Stamp

**Approved for Public Release**

| RECORD OF REVISION | (1) Document Number WHC-SD-WM-ER-617 | Page 1 |
|---|---|---|

(2) Title
Tank Characterization Report for Single-Shell Tank 241-U-105

CHANGE CONTROL RECORD

| (3) Revision | (4) Description of Change - Replace, Add, and Delete Pages | Authorized for Release (5) Cog. Engr. | (6) Cog. Mgr. Date |
|---|---|---|---|
| 0 | (7) Initially released 9/26/96 on EDT-617550. | T. M. Brown | J. G. Kristofzski |
| | | | |
| 0A RS | Incorporate per ECN-638285. | M. J. Kupfer | K. M. Hodgson |
| | | M J Kupfer 8-14-97 | K M Hodgson 8-14-97 |

A-7320-005 (08/91) WEF168

# APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-U-105

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# APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-U-105

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-U-105 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

## D1.0 CHEMICAL INFORMATION SOURCES

Section 4.0 provides characterization results from the 1996 characterization event for this tank. Three core samples were obtained and analyzed. A sample-based inventory was prepared based on the core sample analytical results, a waste density of 1.70 g/mL, and a waste volume of 1,580 kL. The Hanford Defined Waste (HDW) model (Agnew et al. 1996) provides tank contents estimates, derived from process flowsheets and waste volume records.

## D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The sample-based inventory estimate (Section 4.0) and the inventory estimate from the HDW model (Agnew et al. 1996) for tank 241-U-105, are shown in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention.) The waste solids volume used to generate both estimates is 1,580 kL. The estimates, however, use different waste densities. The sample-based inventory used a measured bulk density of 1.70 g/mL. The current HDW model uses a lower waste density of 1.62 g/mL. Few significant differences between the sample-based and HDW model inventories are apparent; only Bi, Ca, Fe, Mn, $CO_3$, and U vary by a factor of two or more.

Table D2-1. Sampling and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-U-105. (2 Sheets)

| Analyte | Sampling inventory estimate[a] (kg) | HDW model inventory estimate[b] (kg) | Analyte | Sampling inventory estimate[a] (kg) | HDW model inventory estimate[b] (kg) |
|---|---|---|---|---|---|
| Al | 44,800 | 68,400 | Nd | <212 | NR |
| Ag | 47.7 | NR | $NH_4$ | NR | 1,705 |
| As | <177 | NR | Ni | 365 | 640 |
| B | 285 | NR | $NO_2$ | 180,000 | 171,000 |
| Ba | <92.3 | NR | $NO_3$ | 752,000 | 531,000 |
| Be | <8.84 | NR | OH | NR | 214,000 |
| Bi | <231 | 509 | oxalate | 24,500 | 5.79 |
| Ca | 688 | 2,720 | Pb | 492 | 351 |
| Ce | <198 | NR | P as $PO_4$ | 30,100 | 19,900 |
| Cd | 47.7 | NR | Sb | <108 | NR |
| Cl | 10,500 | 12,200 | Se | <223 | NR |
| Co | <35.3 | NR | Si | 793 | 3,720 |
| Cr | 6,290 | 4,780 | S as $SO_4$ | 31,300 | 40,900 |
| Cu | 30.8 | NR | Sr | <18.9 | 2.25 |
| F | 3,010 | 2,620 | TIC as $CO_3$ | 126,000 | 59,900 |
| Fe | 7,100 | 1,510 | Ti | <20.3 | NR |
| FeCN/CN | 221 | 0 | TOC | 30,000 | 23,700 |
| Hg | NR | 3.19 | $U_{TOTAL}$ | 5,560 | 62,200 |
| K | 3,680 | 3,650 | V | <89.1 | NR |
| La | <98.2 | 10.7 | W | NR | NR |
| Mg | <323 | NR | Zn | 74.4 | NR |
| Mn | 2,500 | 342 | Zr | 84.9 | 155 |
| Mo | <105 | NR | $H_2O$(Wt%) | 28.6 | 33.2 |

Table D2-1. Sampling and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-U-105. (2 Sheets)

| Analyte | Sampling inventory estimate[a] (kg) | HDW model inventory estimate[b] (kg) | Analyte | Sampling inventory estimate[a] (kg) | HDW model inventory estimate[b] (kg) |
|---|---|---|---|---|---|
| Na | 502,000 | 458,000 | Density (kg/L) | 1.70 | 1.62 |

HDW = Hanford Defined Waste
NR = Not reported
[a] Section 4.0 of this TCR
[b] Agnew et al. (1996).

Table D2-2. Sampling and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-U-105.

| Analyte | Sampling inventory estimate[a] (Ci) | HDW model inventory estimate[b] (Ci) | Analyte | Sampling inventory estimate[a] (Ci) | HDW model inventory estimate[b] (Ci) |
|---|---|---|---|---|---|
| $^{60}$Co | <3,570 | NR | $^{237}$Np | <2,840 | NR |
| $^{90}$Sr | 146,000 | 200,000 | $^{239/240}$Pu | NR | 140 |
| $^{137}$Cs | 384,000 | 404,000 | $^{241}$Am | <70,500 | NR |
| $^{154}$Eu | 1,590 | NR | Total $\alpha$ | 1,800 | NR |
| $^{155}$Eu | <38,200 | NR | | | |

HDW = Hanford Defined Waste
NR = Not reported
[a] Section 4.0 of this TCR
[b] Agnew et al. (1996), decayed to January 1, 1994.

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## D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would influence the sampling-based and HDW model component inventories.

### D3.1 CONTRIBUTING WASTE TYPES

Tank 241-U-105 was put into service in December 1947 as the second tank in the 241-U-104, 241-U-105, and 241-U-106 cascade. The cascade received metal waste from T Plant. Waste began overflowing from tank 241-U-104 in December 1947 and tank 241-U-105 overflowed to tank 241-U-106 in May 1948. In 1957 tank 241-U-105 was sluiced and the metal waste sent to U Plant. After sluicing the tank was declared empty.

The tank received little transfer activity until 1961. In the 1961 to 1962 time period, tank 241-U-105 was used to receive reduction oxidation (REDOX) high-level waste (HLW) and later REDOX cladding waste. Little activity occurred at the tank until 1974 when supernatant was pumped to tank 241-S-110. Beginning in the second quarter 1975, tank 241-U-105 was used to receive and store evaporator bottoms from a number of tanks, as well as transfer supernatant to other tanks.

The current waste volumes for tank 241-U-105 are shown in Table D3-1 (Hanlon 1996).

Table D3-1. Waste Inventory of 241-U-105.

| Waste | Volume (kL) | Volume (kgal) |
|---|---|---|
| Sludge | 121 | 32 |
| Salt cake | 1,320 | 349 |
| Supernatant | 140 | 37 |
| Drainable Liquid | 594 | 157 |
| Total Waste | 1,581 | 418 |

Table D3-2 lists the documented quantities of waste discharged to tank 241-U-105 based on the Waste Status and Transaction Record Summary (WSTRS) (Agnew et al. 1995). These records indicate that the solids in this tank should be mostly Evaporator Bottoms and REDOX HLW. This is consistent with the priority established by the Sort on Radioactive Waste Type (SORWT) model (see Table D3-3).

Table D3-2. Waste Transaction Information for Tank 241-U-105[a].

| Waste source | Waste volume (kL) | Waste volume (kgal) |
|---|---|---|
| $BiPO_4$ Metal Waste | 4,012 | 1,060 |
| Flush Water | 2,010 | 530 |
| $BiPO_4$ Metal Waste | 4,663 | 1,232 |
| Tank sluiced | | |
| Flush Water | 1,420 | 374 |
| REDOX HLW | 481 | 127 |
| REDOX Cladding Waste | 1,220 | 322 |
| 242-T Evaporator Bottoms from 241-TX-106 | 1,090 | 287 |
| Evaporator Waste from 241-TX-118 | 3,590 | 949 |
| 242-S Evaporator Waste from 241-S-102 | 2,640 | 698 |
| 242-S Evaporator Waste from 241-SY-102 | 723 | 191 |
| Total Waste Throughput | 21,840 | 5,770 |
| Current Inventory | 1,580 | 418 |

[a] Agnew et al. (1995).

The types of solids accumulated in tank 241-U-105 reported by various authors are compiled in Tables D3-3 and Table D3-4.

Table D3-3. Expected Solids for Tank 241-U-105. (2 sheets)

| Reference | Waste type |
|---|---|
| (Anderson 1990) | MW, R, R-CW, EB, Resid. HDRL, CCPLX |
| SORWT Model (Hill et al. 1995) | EB, CW, R |
| WSTRS (Agnew et al. 1995) | MW, R, CW, EB, HDRL, CCPLX |

Table D3-3. Expected Solids for Tank 241-U-105. (2 sheets)

| Reference | Waste type |
|---|---|
| HDW Model (Agnew et al. 1996) | MW, SMMT2, SMMS2 |

CCPLX = Complexant concentrate
CW = Cladding waste
EB = Evaporator bottoms
HDRL = Hanford Defense Residual Liquid
HDW = Hanford Defined Waste
MW = Metal waste
R = REDOX high-level waste
Resid. = Residual
SMMS2 = Supernatant Mixing Model salt cake waste generated from the 242-S Evaporator/Crystallizer from 1977 until 1980
SMMT2 = Supernatant Mixing Model salt cake waste generated from the 242-T Evaporator/crystallizer from 1955 until 1965
SORWT = Sort on Radioactive Waste Type
WSTRS = Waste Status and Transaction Record Summary.

Table D3-4. Hanford Defined Waste Model Solids for Tank 241-U-105.

| Tank layer model solids layer | kL |
|---|---|
| MW | 121 |
| SMMT2 | 280 |
| SMMS2 | 1,041 |

MW = Metal waste
SMMS2 = Supernatant Mixing Model salt cake waste generated from the 242-S Evaporator/Crystallizer from 1977 until 1980
SMMT2 = Supernatant Mixing Model salt cake waste generated from the 242-T Evaporator/crystallizer from 1955 until 1965.

The current assessment of the sample data, the most recent WSTRS document (Agnew et al. 1995), as well as the Anderson (1990) document, support the position that metal waste was removed from tank 241-U-105 and that the solids heel existing before receipt of evaporator solids consists of REDOX HLW and cladding waste. Appendix C and Appendix D of the HDW model incorrectly identify the sludge heel as $BiPO_4$ metal waste (Agnew et al. 1996).

## D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Detailed review of the WSTRS document, and TCR indicate that tank 241-U-105 received 481 kL of REDOX HLW (R2) waste and 1,220 kL of REDOX cladding waste (CWR2) and that essentially all the MW was removed during sluicing.

Table D3-5 re-calculates the HDW model inventory without the contribution from the metal waste. The HDW model estimate of tank 241-U-105 contents includes 121 kL of metal waste (MW1).

Table D3-5. Hanford Defined Waste Model Inventory Estimate of Tank 241-U-105 Without $BiPO_4$ Metal Waste. (2 Sheets).

| Species | MW1 sludge composition from HDW model (ppm) | MW1 sludge inventory in HDW model (kg) | HDW model inventory estimate (kg) | HDW model inventory estimate without MW1 (kg) |
|---|---|---|---|---|
| Al | 0 | 0 | 68,400 | 68,400 |
| Bi | 0 | 0 | 509 | 503 |
| Ca | 1,930.4 | 408 | 2,720 | 2,310 |
| Cl | 25.533 | 5.4 | 12,200 | 12,200 |
| Cr | 36.925 | 7.8 | 4,780 | 4,770 |
| F | 0 | 0 | 2,620 | 2,620 |
| Fe | 3,794.1 | 803 | 1,510 | 707 |
| FeCN/CN | 0 | 0 | 0 | 0 |
| Hg | 0 | 0 | 3.19 | 3.19 |
| K | 6.1257 | 1.3 | 3,650 | 3,650 |
| La | 0 | 0 | 10.7 | 10.7 |
| Mn | 0 | 0 | 342 | 342 |
| Na | 66,335 | 14,000 | 458,000 | 444,000 |
| $NH_4$ | 0.0362 | 0.008 | 1,705 | 1,705 |
| Ni | 20.845 | 4.41 | 640 | 640 |
| $NO_2$ | 241.05 | 51 | 171,000 | 175,000 |
| $NO_3$ | 2,216.8 | 469 | 531,000 | 531,000 |
| OH | 127.111 | 27 | 214,000 | 214,000 |
| oxalate | 0 | 0 | 5.79 | 5.79 |
| Pb | 0 | 0 | 351 | 351 |

Table D3-5. Hanford Defined Waste Model Inventory Estimate of Tank 241-U-105 Without $BiPO_4$ Metal Waste. (2 Sheets)

| Species | MW1 sludge composition from HDW model (ppm) | MW1 sludge inventory in HDW model (kg) | HDW model inventory estimate (kg) | HDW model inventory estimate without MW1 (kg) |
|---|---|---|---|---|
| P as $PO_4$ | 21,734 | 4,593 | 19,900 | 15,300 |
| Si | 24.934 | 5.26 | 3,720 | 3,720 |
| S as $SO_4$ | 4,510.56 | 953 | 40,900 | 39,900 |
| Sr | 0 | 0 | 2.25 | 2.25 |
| TIC as $CO_3$ | 64,793 | 13,700 | 59,900 | 46,200 |
| $U_{TOTAL}$ | 270,906 | 57,300 | 62,200 | 4,900 |
| Zr | 0 | 0 | 155 | 155 |
| Density | 1.7467 | 0 | 1.62 | |

HDW = Hanford Defined Waste
MW1 = metal waste generated from the bismuth phosphate process from 1944 through 1951.

Table D3-6 estimates the inventory of REDOX HLW and cladding waste (CW) added to tank 241-U-105 based on REDOX Flowsheet No. 6 as defined in Appendix D of Kupfer et al. (1997). The inventories are based on tank 241-U-105 receipts of 481 kL of REDOX HLW waste and 1,220 kL of REDOX CW.

The data in Table D3-6 must be further modified to reflect the impact of supernatant transfers out of the tank 241-U-105 on the REDOX HLW and REDOX CW inventory. These adjustments can be based on empirical factors derived from other tank samples.

Table D3-6. Reduction Oxidation Wastes Added to Tank 241-U-105. (2 Sheets)

| Species | REDOX HLW (kg) | REDOX CW (kg) | Total REDOX Waste (kg) |
|---|---|---|---|
| Al | 12,400 | 63,400 | 75,800 |
| Bi | 4.9 | NR | 4.9 |
| $C_2O_4^{-3}$ | 342 | NR | 342 |
| Cr | 3,290 | NR | 3,290 |
| F | NR | NR | NR |

Table D3-6. Reduction Oxidation Wastes Added to Tank 241-U-105. (2 Sheets)

| Species | REDOX HLW (kg) | REDOX CW (kg) | Total REDOX Waste (kg) |
|---|---|---|---|
| Fe | 202 | NR | 202 |
| I | 2.7 | NR | 2.7 |
| K | NR | NR | NR |
| Mn | NR | NR | NR |
| Na | 80,200 | 134,800 | 215,000 |
| $NO_2$ | 0 | 81,200 | 81,200 |
| $NO_3$ | 114,000 | 60,100 | 174,100 |
| Si | 0 | 942 | 942 |
| $SO_4$ | 1,010 | NR | 1,010 |
| U | 75.9 | 1,625 | 1,700 |
| Zr | NR | NR | NR |

CW = Coating (cladding) waste
HLW = High-level waste
NR = Not reported
REDOX = Reduction oxidation.

Tank 241-U-204 is considered to be a good example of REDOX CW and tank 241-SX-108 is considered to be an example of REDOX HLW. Examination of the best-basis evaluation for these tanks indicates the following:

- Bi, Fe, Si, and U fully precipitate.
- 9 percent of the Al precipitates in REDOX HLW and 30 percent precipitates in REDOX CW.
- 7 percent of the Cr precipitates in REDOX HLW.
- 10 percent of the sulfate precipitates in REDOX HLW.
- Na, $NO_2$, $NO_3$, I, and oxalate remain dissolved in the interstitial liquid.
- The interstitial liquid volume is 65.085 percent of the sludge volume.

Table D3-7 shows the calculated composition of the precipitated REDOX HLW and CW sludge using the characteristics of 241-U-204 and 241-SX-108 waste.

Table D3-7. Reduction Oxidation Wastes Precipitated or Trapped in Tank 241-U-105 Sludge.

| Species | REDOX HLW (kg) | REDOX CW (kg) | Total REDOX Waste (kg) |
|---|---|---|---|
| Al | 1,120 | 19,020 | 20,100 |
| Bi | 4.9 | NR | 4.9 |
| oxalate | 16 | NR | 16 |
| Cr | 230 | NR | 230 |
| F | NR | NR | NR |
| Fe | 202 | NR | 202 |
| I | 0.1 | NR | 0.1 |
| K | NR | NR | NR |
| Mn | NR | NR | NR |
| Na | 3,760 | 6,320 | 10,100 |
| $NO_2$ | 0 | 3,810 | 3,810 |
| $NO_3$ | 5,340 | 2,820 | 8,160 |
| Si | 0 | 942 | 942 |
| $SO_4$ | 101 | NR | 101 |
| U | 75.9 | 1,625 | 1,700 |
| Zr | NR | NR | NR |

CW = Coating (cladding) waste
HLW = High-level waste
NR = Not reported
REDOX = Reduction oxidation.

Table D3-8 re-calculates the HDW model inventory by adding back in the contribution from the REDOX wastes shown in Table D3-7.

Table D3-8. Revised Hanford Defined Waste Model Inventory Estimate of Tank 241-U-105.

| Species | HDW model inventory estimate without MW1 (kg) | REDOX sludge inventory estimate from Table D3-7 (kg) | Revised HDW model inventory estimate (kg) |
|---|---|---|---|
| Al | 68,400 | 20,100 | 88,500 |
| Bi | 503 | 4.9 | 508 |
| Ca | 2,310 | | 2,310 |
| Cl | 12,200 | | 12,200 |
| Cr | 4,770 | 230 | 5,000 |
| F | 2,620 | | 2,620 |
| Fe | 707 | 202 | 909 |
| FeCN/CN | 0 | | 0 |
| Hg | 3.19 | | 3.19 |
| K | 3,650 | | 3,650 |
| La | 10.7 | | 10.7 |
| Mn | 342 | | 342 |
| Na | 444,000 | 10,100 | 454,000 |
| $NH_4$ | 1,705 | | 1,705 |
| Ni | 640 | | 640 |
| $NO_2$ | 175,000 | 3,810 | 179,000 |
| $NO_3$ | 531,000 | 8,160 | 539,000 |
| OH | 214,000 | | 214,000 |
| oxalate | 5.79 | 16 | 22 |
| Pb | 351 | | 351 |
| P as $PO_4$ | 15,300 | | 15,300 |
| Si | 3,720 | 942 | 4,660 |
| S as $SO_4$ | 39,900 | 101 | 40,000 |
| Sr | 2.25 | | 2.25 |
| TIC as $CO_3$ | 46,200 | | 46,200 |
| $U_{TOTAL}$ | 4,900 | | 1,700 |
| Zr | 155 | | 155 |

HDW = Hanford Defined Waste
REDOX = Reduction oxidation.

The result of this revision to the HDW model is an improved reconciliation with the sampling-based estimate for U. However, for several other species, Al, Fe, Si, $SO_4$, $PO_4$, and total inorganic carbon (TIC), the difference between the sampling-based estimate and the HDW model estimate is increased. Al, Si, and $SO_4$ are apparently overestimated by the HDW model and Fe, $PO_4$, and TIC are underestimated.

Photos of the tank interior show a light yellow colored salt cake over about half of the tank. The remainder of the surface is covered by a dark supernatant pool. The photo is current relative to the inventory shown in Table D3-1.

## D3.3 DOCUMENT ELEMENT BASIS

Few significant differences between the sample-based and HDW model inventories are apparent, only Bi, Ca, Fe, Mn, $CO_3$, and U vary by a factor of two or more. After the revision made by the independent evaluation, the species that vary by a factor of two or more are Al, Bi, Ca, Fe, Mn, Si, $PO_4$, and $CO_3$. The sample-based inventory used a measured bulk density of 1.70 g/mL. The current HDW model uses a lower waste density of 1.62 g/mL.

**Aluminum.** The sample-based estimate, HDW model, and independent evaluation for aluminum are 44,800 kg, 68,400 kg, and 88,500 kg, respectively. The high Al estimates of the HDW model and the independent evaluation may be biased by the overall Al inventory assumed in the HDW model and the high precipitation factor determined for REDOX cladding waste.

**Bismuth.** The sample-based estimate, HDW model, and independent evaluation for bismuth are <231 kg, 509 kg, and 508 kg, respectively. The source of Bi in the HDW model would appear to be due the assumptions made for the SMMT2 and/or SMMS2 models. The independent evaluation has not identified a source of bismuth for this tank.

**Calcium.** The sample-based estimate, HDW model, and independent evaluation for calcium are 688 kg, 2,720 kg, and 2,310 kg, respectively. The source of Ca in the HDW model would appear to be due the assumptions made for the SMMT2 and/or SMMS2 models.

**Iron.** The sample-based estimate, HDW model, and independent evaluation for iron are 7,100 kg, 1,510 kg, and 909 kg, respectively. The source of iron in the 241-U-105 tank may be the complexed waste reported by Anderson (1990).

**Manganese.** The sample-based estimate, HDW model, and independent evaluation for manganese are 2,500 kg, 342 kg, and 342 kg, respectively. The source of Mn found in the sample-based inventory has not been identified. It is expected that Mn would have precipitated and would have been introduced to tank 241-U-105 by supernatant or salt cake slurry transfers. Although early REDOX wastes contained Mn, the REDOX wastes added to tank 241-U-105 appear to have been generated after the $KMnO_4$ process was discarded. Section 5.13 states that $KMnO_4$ was used in REDOX until September 1959, whereas the REDOX waste additions were made to 241-U-105 after October 1960. Manganese may also have been added as a decontamination agent from T Plant via the SMMT2 or SMMS2 model.

**Silicon**. The sample-based estimate, HDW model, and independent evaluation for silicon are 792 kg, 3,720 kg, and 4,660 kg, respectively. The HDW model indicates that 3,720 kg of silicon are introduced to tank 241-U-105 in the SMMT2 and SMMS2 models. The assumptions in these models have not been examined.

**Sulfate**. The sample-based estimate, HDW model, and independent evaluation for sulfate are 31,300 kg, 40,900 kg, and 39,900 kg, respectively. The HDW model indicates that 40,900 kg of sulfate are introduced to tank 241-U-105 in the SMMT2 and SMMS2 models. This number, without the contribution from the REDOX wastes, is substantially larger than the sample-based inventory.

**Phosphate**. The sample-based estimate, HDW model, and independent evaluation for phosphate are 30,100 kg, 19,900 kg, and 15,300 kg, respectively. Comparison of these three values suggests that the tank contains more phosphate bearing salt cake than was identified in the transaction records. A possible source of the additional phosphate might be phosphate based decontamination agents used at T Plant and other facilities.

**Total Inorganic Carbon**. The sample-based estimate, HDW model, and independent evaluation for TIC as $CO_3$ are 126,000 kg, 59,900 kg, and 46,200 kg, respectively.. The sample data suggest that the tank contains more TIC in the salt cake than is calculated by the SMMT2 and SMMS2 models.

**Total Hydroxide.** Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997).

## D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

The results from this evaluation support using the sampling data for tank 241-U-105 for the following reasons.

1. Core sample data from three risers, at approximately two widely spaced positions, were used to estimate component inventories. Recovery of sample segments, however, was poor.

2. The sample-based inventory reconciles better with the position that the sludge layer in the tank is REDOX HLW and REDOX CW rather than $BiPO_4$ MW.

3. The multitude of waste types that are in the tank or were added to the tank and later removed has resulted in a tank history that is sufficiently complex that comparison to process flowsheets is impractical.

Best-basis inventory estimates for tank 241-U-105 are presented in Tables D4-1 and D4-2. The projected inventory is based on a volume of 1,580 kL and a sample-derived waste density of 1.70 g/mL.

The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported $^{90}Sr$, $^{137}Cs$, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as $^{60}Co$, $^{99}Tc$, $^{129}I$, $^{154}Eu$, $^{155}Eu$, and $^{241}Am$, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides ($^{90}Sr$, $^{137}Cs$, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the HDW model. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-U-105 (Effective January 31, 1997). (2 sheets)

| Analyte | Total inventory (kg) | Basis (S, M, or C)[1] | Comment |
|---|---|---|---|
| Al | 44,800 | S | % Mean RSD=23.3 |
| Bi | <231 | S | |
| Ca | 688 | S | %Mean RSD=17.8 |
| Cl | 10,500 | S | %Mean RSD=9.55 |
| TIC as $CO_3$ | 126,000 | S | %Mean RSD= 17.0 |
| Cr | 6,290 | S | %Mean RSD=15.6 |
| F | 3,010 | S | %Mean RSD=22.6 |
| Fe | 7,100 | S | %Mean RSD=24.4 |
| Hg | 3.19 | M | Rev. 3 model value |
| K | 3,680 | S | %Mean RSD=6.79 |
| La | <98.2 | S | |
| Mn | 2,500 | S | %Mean RSD=48.1 |
| Na | 502,000 | S | %Mean RSD=2.25 |
| Ni | 365 | S | %MEAN RSD=8.05 |
| $NO_2$ | 180,000 | S | %Mean RSD=6.34 |
| $NO_3$ | 752,000 | S | %Mean RSD=6.65 |
| $OH_{TOTAL}$ | 82,700 | C | Based on charge balance |
| P as $PO_4$ | 30,100 | S | %Mean RSD=28.4 |
| Pb | 492 | S | %Mean RSD=17.2 |
| S as $SO_4$ | 31,300 | S | %Mean RSD=11.2 |
| Si | 793 | S | %Mean RSD=15.9 |
| Sr | <18.9 | S | |
| TOC | 30,000 | S | %Mean RSD=5.92 |
| $U_{TOTAL}$ | 5,560 | S | %Mean RSD=61.5 |

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-U-105 (Effective January 31, 1997). (2 sheets)

| Analyte | Total inventory (kg) | Basis (S, M, or C)[1] | Comment |
|---|---|---|---|
| Zr | 84.9 | S | %Mean RSD=31.7 |

[1]S = Sample-based

M = Hanford Defined Waste model-based (Agnew 1996)

C = Calculated by charge balance; includes oxides as hydroxides, not including $CO_3$, $NO_2$, $NO_3$, $PO_4$, $SO_4$, and $SiO_3$.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-105 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

| Analyte | Total inventory (Ci) | Basis (S, M, or E)[1] | Comment |
|---|---|---|---|
| $^{3}H$ | 427 | M | |
| $^{14}C$ | 62.9 | M | |
| $^{59}Ni$ | 4.08 | M | |
| $^{60}Co$ | 70.1 | M | |
| $^{63}Ni$ | 400 | M | |
| $^{79}Se$ | 6.25 | M | |
| $^{90}Sr$ | 154,000 | S | %Mean RSD=9.24 |
| $^{90}Y$ | 154,000 | S | Equilibrium value with $^{90}Sr$ |
| $^{93m}Nb$ | 22.2 | M | |
| $^{93}Zr$ | 30.7 | M | |
| $^{99}Tc$ | 446 | M | |
| $^{106}Ru$ | 0.0127 | M | |
| $^{113m}Cd$ | 161 | M | |
| $^{125}Sb$ | 303 | M | |
| $^{126}Sn$ | 9.44 | M | |
| $^{129}I$ | 0.86 | M | |
| $^{134}Cs$ | 5.09 | M | |
| $^{137m}Ba$ | 383,000 | S | Equilibrium value with $^{137}Cs$ |
| $^{137}Cs$ | 404,500 | S | %Mean RSD=7.37 |
| $^{151}Sm$ | 22,000 | M | |

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-105 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

| Analyte | Total inventory (Ci) | Basis (S, M, or E)[1] | Comment |
|---|---|---|---|
| $^{152}Eu$ | 7.5 | M | |
| $^{154}Eu$ | 1,140 | M | |
| $^{155}Eu$ | 445 | M | |
| $^{226}Ra$ | 2.84 E-04 | M | |
| $^{227}Ac$ | 0.00174 | M | |
| $^{228}Ra$ | 0.29 | M | |
| $^{229}Th$ | 0.00679 | M | |
| $^{231}Pa$ | 0.00783 | M | |
| $^{232}Th$ | 0.0192 | M | |
| $^{232}U$ | 1.47 | M | |
| $^{233}U$ | 5.65 | M | |
| $^{234}U$ | 18.2 | M | |
| $^{235}U$ | 0.81 | M | |
| $^{236}U$ | 0.154 | M | |
| $^{237}Np$ | 1.61 | M | |
| $^{238}Pu$ | 2.61 | M | |
| $^{238}U$ | 18.7 | M | |
| $^{239}Pu$ | 89.5 | M | |
| $^{240}Pu$ | 15.2 | M | |
| $^{241}Am$ | 107 | M | |
| $^{241}Pu$ | 177 | M | |
| $^{242}Cm$ | 0.287 | M | |
| $^{242}Pu$ | 9.74 E-04 | M | |
| $^{243}Am$ | 0.00382 | M | |
| $^{243}Cm$ | 0.0266 | M | |
| $^{244}Cm$ | 0.259 | M | |

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
NR = Not reported.

## D5.0 APPENDIX D REFERENCES

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