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# ENGINEERING DATA TRANSMITTAL

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Page 1 of 1

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| | | Env. | | | | 3 | | R. T. Winward | | | H5-49 |

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# Preliminary Tank Characterization Report for Single-Shell Tank 241-SX-104: Best-Basis Inventory

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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-SX-104 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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# PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-SX-104: BEST-BASIS INVENTORY

August 1997

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# PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-SX-104: BEST-BASIS INVENTORY

This document is a preliminary Tank Characterization Report (TCR) and contains only the current best-basis inventory (Appendix D) for single-shell tank 241-SX-104. No TCRs have been previously issued for this tank. Consequently, the best-basis inventory is based on an independent assessment of waste type, process flow sheet data, early sample data, and other available information.

The *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes* (Kupfer et al. 1997) describes standard methodology used to derive the tank-by-tank best-basis inventories. This preliminary TCR will be updated using this same methodology when additional data on tank contents become available.

## REFERENCE

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz ($W^2S$ Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

# APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-SX-104

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# APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-SX-104

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-SX-104 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

There is no previous Tank Characterization Report (TCR) for tank 241-SX-104. Available information for tank 241-SX-104 includes the following:

- Analytical data from other S and U Tank Farms with similar Supernatant Mixing Model S Plant (SMMS) salt cake waste and Reduction and Oxidation (REDOX [R]) sludge waste types.
- The Hanford Defined Waste (HDW) model document (Agnew et al. 1996) provides tank content estimates.

## D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Hanford Defined Waste model inventories, generated by HDW model, are shown in Tables D2-1 and D2-2. No samples have been taken from tank 241-SX-104 that can be used to estimate tank inventories for comparison with the HDW model estimate. The tank volume used to generate the HDW inventory is 2,324 kL (614 kgal) waste which is partitioned into 640 kL (169 kgal) sludge, 1,684 kL (445 kgal) salt cake (Agnew et al. 1996), which differs from the 2,324 kL (614 kgal) waste which is partitions into 515 kL (136 kgal) sludge, 1,809 kL (478 kgal) salt cake reported by Hanlon (1996). The HDW model sludge density used is 1.49 g/mL and salt cake density used is 1.60 g/mL. (The chemical species are reported without charge designation per the best-basis inventory convention.)

Table D2-1. Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-SX-104. (2 Sheets)

| Analyte | HDW[a] inventory estimate (kg) | Analyte | HDW[a] inventory estimate (kg) |
|---|---|---|---|
| Al | 130,000 | $NO_3$ | 669,000 |
| Bi | 476 | OH | 364,000 |
| Ca | 6,560 | oxalate | 4.98 |
| Cl | 15,000 | Pb | 384 |
| Cr | 25,800 | P as $PO_4$ | 15,800 |
| F[b] | 2,440 | Si | 5,230 |
| Fe | 22,200 | S as $SO_4$ | 44,900 |
| Hg | 3.29 | Sr | 1.93 |
| K | 4,350 | TIC as $CO_3$ | 55,700 |
| La | 9.19 | TOC | 24,800 |
| Mn | 400 | $U_{TOTAL}$ | 9,500 |
| Na | 568,000 | Zr | 143 |
| Ni | 2,050 | $H_2O$ (Wt%) | 38.4 |
| $NO_2$ | 256,000 | density (kg/L) | 1.57 |

HDW = Hanford Defined Waste
[a] Agnew et al. (1996)
[b] Fluoride based on water soluble portion only.

Table D2-2. Predicted Inventory Estimates for Radioactive Components in Tank 241-SX-104.

| Analyte | HDW[a] inventory estimate (Ci) | Analyte | HDW[a] inventory estimate (Ci) |
|---|---|---|---|
| $^{90}Sr$ | 688,000 | $^{239/240}Pu$ | 197 |
| $^{137}Cs$ | 561,000 | | |

HDW = Hanford Defined Waste
[a] Agnew et al. (1996) radionuclides decayed to January 1, 1994.

# D3.0 COMPONENT INVENTORY EVALUATION

## D3.1 WASTE HISTORY TANK 241-SX-104

Tank 241-SX-104 was filled with waste from the REDOX facility from the first quarter of 1955 until the third quarter of 1971. Tank 241-SX-104 was a primary receiver of R1 waste directly from the REDOX Plant. Waste was cycled through the evaporator between 1971 and 1976. Some of the waste supernatants were evaporated in the tank to salt cake during a period that the waste in tank 241-SX-104 was self-boiling. Periodically waste was received and removed from the tank between 1976 and 1983. Receipt of the last transfer of waste was in 1980 from tank 241-S-103. The tank was removed from service and labeled inactive in 1980. The tank was partially isolated in June 1985. Between June 1988 and June 1989, 428.5 kL (113.2 kgal) of liquid were salt well jet pumped.

## D3.2 CONTRIBUTING WASTE TYPES

The HDW model (Agnew et al. 1996) predicts that the tank contains a total of 2,324 kL (614 kgal) of waste which consists of first-cycle REDOX process high-level waste (375 kL [99 kgal], R1), RSltCk (265 kL [70 kgal]), and 1,684 kL (445 kgal) of salt cake (SMMS1) predicted from the SMM.

The Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) lists R (high-level REDOX waste), and evaporator bottoms (EB) as the primary and secondary waste types respectively. EB waste is the SORWT definition for salt cake that is equivalent to the SMM waste type. SORWT also lists REDOX Ion Exchange (RIX) waste as a tertiary waste contributor.

Hanlon (1996) indicates 2,324 kL (614 kgal) of waste which consists of 515 kL (136 kgal) of sludge and 1,809 kL (478 kgal) of salt cake. No description of the source of the sludge and salt cake are given.

## D3.3 INVENTORY EVALUATION

The following evaluation provides an engineering assessment of tank 241-SX-104 contents. For this evaluation, the following assumptions and observations are made:

- Tank volumes listed in Hanlon (1996) are used over Agnew et al. (1996). Both sources use the same total waste volumes but differ in the breakdown of sludge and salt cake volumes.

- Only the SMMS1, RSltCk, and R waste streams contributed to solids formation.

## D3.4 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Table D3-1 shows the engineering evaluation approaches used on tank 241-SX-104.

Table D3-1. Engineering Evaluation Approaches Used On Tank 241-SX-104.

| Type of waste | How calculated | Check method |
|---|---|---|
| Supernate | Assumed no supernate | None, no supernate present. |
| Salt cake<br>Volume = 1,809 kL (478 kgal)<br>Density = 1.63 g/mL | Used sample-based concentrations from tanks with SMMS1 salt cake waste. | None, no sampling data available for this tank. |
| Sludge<br>Volume = 515 kL (136 kgal)<br>Density = 1.77 g/mL | Used the average analyte concentration from tank 241-S-102, 241-S-104, and 241-S-107. All have sample data and R1 waste. Only the segments that are believed to have R1 waste were used to calculate the concentration from each tank. | None, no sample-based information is available for this tank. |

R = REDOX (reduction and oxidation) sludge waste
SMMS = Supernatant mixing model S Plant.

### D3.4.1 Basis for Salt Cake Calculations Used in This Engineering Evaluation

For this evaluation the methodology developed for SMMS1 salt cake was used. This is based on comparing concentrations from S and U Tank Farm sample data shown in Table D3-2. Tanks 241-S-101 (Kruger et al. 1996), 241-S-102 (Eggers et al. 1996), 241-U-106 (Brown et al. 1997), and 241-U-109 (Baldwin and Stephens 1996) were used to produce the average salt cake analyte concentrations for SMMS1 salt cake that were used in this comparison. It is assumed in this evaluation that the composition of the SMMS1 salt cake also represents the composition of the 265 kL (70 kgal) RSltCk expected to be in tank 241-SX-104. The RSltCk formed when the waste in tank 241-SX-104 was self boiling. To calculate the average SMMS1 concentration the waste volume and predicted location from Agnew et al. (1996) for SMMS1 layers in each tank was determined. The TCR sample data was reviewed and using the segments that were located within the predicted location from Agnew et al. (1996), an average concentration was calculated. The concentrations from each tank and the segments used in the calculation are shown in Table D3-2. For comparison the SMM salt cake composition predicted by the HDW model for tank 241-SX-104 is also shown.

Table D3-2. SMMS1 Salt Cake Concentrations. (2 Sheets)

| Analyte | 241-S-101 segments 2L-4U[a] µg/g | 241-S-102 segments 7L-10U[b] µg/g | 241-U-106 segments 2U-4L[c] µg/g | 241-U-109 segments 5U-8L[d] µg/g | Average concentration[e] µg/g | HDW model SMM concentration for tank 241-SX-104[f] µg/g |
|---|---|---|---|---|---|---|
| Al | 18,000 | 15,085 | 13,620 | 13,625 | 15,100 | 29,200 |
| Ag | 12 | 17 | 16 | NR | 15 | NR |
| B | 110 | 75 | 80 | NR | 88 | NR |
| Bi | 71 | 76 | <DL | <DL | 73.5 | 177 |
| Ca | 273 | 237 | 336 | <DL | 282 | 940 |
| Cl | 4,500 | 4,099 | 2,926 | NR | 3,842 | 4,990 |
| Cr | 10,000 | 4,359 | 3,170 | 4,233 | 5,440 | 2,100 |
| F | 500 | 13,596 | 4,669 | NR | 6,255 | 907 |
| Fe | 508 | 1,298 | 3,096 | <DL | 1,630 | 288 |
| K | 1,109 | 898 | 1,309 | NR | 1,110 | 1,480 |
| La | <DL | 37 | 43 | NR | 40 | 3.42 |
| Mn | 266 | 597 | 1,189 | <DL | 684 | 148 |
| Na | 150,000 | 189,500 | 170,500 | 218,300 | 182,000 | 184,000 |
| Ni | 114 | 49 | 304 | <DL | 155 | 260 |
| $NO_2$ | 91,000 | 40,100 | 56,000 | 42,900 | 57,500 | 74,500 |
| $NO_3$ | 110,000 | 99,200 | 147,200 | 297,000 | 163,000 | 216,000 |
| Pb | 91 | 137 | 348 | NR | 192 | 139 |
| $PO_4$ | 9,500 | 114,500 | 5,888 | 5,970 | 34,000 | 5,880 |
| P | 2,290 | 33,900 | 1,949 | <DL | 12,700 | NR |
| S | 5,940 | 2,683 | 3,878 | NR | 4,170 | NR |
| Si | 5,269 | 517 | 176 | <DL | 1,990 | 1,5740 |
| $SO_4$ | 20,700 | 12,500 | 10,774 | 11,100 | 13,800 | 16,100 |
| Sr | 7 | <DL | <DL | NR | 7 | NR |
| TOC | 1,900 | 5,340 | 24,626 | 3,920 | 8,950 | 9,220 |
| U | 560 | 1,403 | 781 | <DL | 914 | 2,020 |
| Zn | 30 | 32 | 54 | <DL | 39 | NR |
| Zr | 14 | 39 | 88 | NR | 47 | 53.2 |
| Oxalate | 15,400 | 15,700 | 9,880 | NR | 13,700 | 1.85 |
| Density g/mL | 1.58 | 1.69 | 1.57 | 1.67 | 1.63 | 1.46 |

Table D3-2. SMMS1 Salt Cake Concentrations. (2 Sheets)

| Analyte | 241-S-101 segments 2L-4U[a] µg/g | 241-S-102 segments 7L-10U[b] µg/g | 241-U-106 segments 2U-4L[c] µg/g | 241-U-109 segments 5U-8L[d] µg/g | Average concentration[e] µg/g | HDW model SMM concentration for tank 241-SX-104[f] µg/g |
|---|---|---|---|---|---|---|
| Radionuclides[g] (µCi/g) | | | | | | |
| $^{90}Sr$ | 252 | .23 | 77 | 9 | ·90 | 62 |
| $^{137}Cs$ | 175 | 121 | 175 | 142 | 153 | 162 |

<DL = Less then the Detectable Limit.
HDW = Hanford Defined Waste
NR = Not reported
SMMS1 = Supernatant Mixing Model 242-S Evaporator salt cake generated from 1973 until 1976
[a] Kruger et al. (1996)
[b] Eggers et al. (1996)
[c] Brown et al. (1997)
[d] Baldwin and Stephens (1996)
[e] Average of tank 241-S-101, 241-S-102, 241-U-106, and 241-U-109 concentrations
[f] Agnew et al. (1996)
[g] Radionuclides are reported as of the date of sample analysis.

### D3.4.2 Basis for Sludge Calculations Used in This Engineering Evaluation

Data from tanks 241-S-102 (Eggers, et al., 1996), 241-S-104 (DiCenso et al. 1994), and 241-S-107 (Simpson, et al., 1996) were used to produce average analyte concentrations for R1 sludge waste. To calculate the average concentration, the volumes and predicted location of the sludge were taken from Agnew et al. (1996) for the R1 waste. The TCR sample data were then reviewed, and only the segments that were located within the predicted sludge location from Agnew et al. (1996) were used in deriving an average concentration. The average concentration from each tank and the segments used in the calculation is shown below in Table D3-3. For comparison the average sludge layer composition predicted by the HDW model for tank 241-SX-104 is also shown.

Table D3-3. R1 Sludge Concentration μg/g (Average from Tanks with Tank Characterization Reports) for Tank 241-SX-104. (2 Sheets)

| Analyte | 241-S-101 segments 7U-8L[a] (μg/g) | 241-S-104 (total sludge concentration)[b] (μg/g) | 241-S-107 segments[c] (μg/g) | Average concentration[d] (μg/g) | HDW model sludge values for 241-SX-104[e] (μg/g) |
|---|---|---|---|---|---|
| Al | 127,000 | 117,000 | 56,400 | 100,000 | 54,300 |
| Bi | <38.8 | <45.7 | NR | <42.2 | 0.44 |
| Ca | 322 | 247 | 234 | 268 | 4,250 |
| Cl | 2,050 | 3,200 | 1,860 | 2,370 | 1,700 |
| Cr | 2,230 | 2,350 | 1,180 | 1,920 | 21,200 |
| F | <65.7 | 145 | 150 | <120 | 2.29 |
| Fe | 1,960 | 1,720 | 1,160 | 1,613 | 22,600 |
| Hg | NR | <0.126 | NR | <0.126 | 0.0663 |
| K | 539 | 300 | 457 | 432 | 408 |
| La | <19.5 | <2.07 | NR | <10.8 | 1.13 E-06 |
| Mn | 2,750 | 1,150 | 83 | 1,330 | 0.841 |
| Na | 112,000 | 121,000 | 60,400 | 97,800 | 78,200 |
| Ni | 90.7 | 56 | 206 | 118 | 1,420 |
| $NO_2$ | 31,100 | 25,900 | 34,300 | 30,433 | 59,200 |
| $NO_3$ | 119,000 | 191,000 | 57,600 | 122,500 | 92,300 |
| Pb | 37 | 29.6 | 33 | 33.2 | 10.9 |
| $PO_4$ | 1,360 | <2,190 | 1,630 | <1,730 | 12.9 |
| Si | 1,360 | 1,330 | 1,060 | 1,250 | 1,140 |
| $SO_4$ | 897 | 2,270 | 1,300 | 1,489 | 1,760 |
| Sr | 456 | 424 | 378 | 420 | 2.17 E-06 |
| TIC as $CO_3$ | NR | 4,140 | NR | 4,140 | 6,450 |
| TOC | NR | 1,730 | NR | 1,730 | 27.5 |
| U | 7,684 | 6,690 | 8,685 | 7,690 | 4,270 |
| Zr | 36 | 33.6 | 131 | 66.9 | 0.0931 |

Table D3-3. R1 Sludge Concentration μg/g (Average from Tanks with Tank Characterization Reports) for Tank 241-SX-104. (2 Sheets)

| Analyte | 241-S-101 segments 7U-8L[a] (μg/g) | 241-S-104 (total sludge concentration)[b] (μg/g) | 241-S-107 segments[c] (μg/g) | Average concentration[d] (μg/g) | HDW model sludge values for 241-SX-104[e] (μg/g) |
|---|---|---|---|---|---|
| Radionuclides (μCi/g) | | | | | |
| $^{90}Sr$ | NR | 301[f] | 276[f] | 288[f] | 4.84 |
| $^{137}Cs$ | 98[f] | 60.5[f] | 74[f] | 77.6[f] | 112 |
| density (g/mL) | 1.77 | 1.64 | 1.90 | 1.77 | 1.49 |

NR = Not reported.
HDW = Hanford Defined Waste.
[a] Kruger et al. (1996)
[b] DiCenso et al. (1994)
[c] Statistically determined median R1 sludge concentrations for tank 241-S-107 contained in the attachment to Simpson et al. (1996)
[d] Average of analyte concentrations for tankS 241-S-101, 241-S-104, and 241-S-107
[e] Agnew et al. (1996)
[f] Radionuclides decayed to January 1, 1994.

## D3.5 ESTIMATED COMPONENT INVENTORIES

The Chemical inventory of tanks 241-SX-104 is estimated from the assumed salt cake and sludge volumes (Table D3-1). The resulting inventories are provided in Table D3-4. The inventories estimated by the HDW model are included for comparison.

Since no post-1989 analytical data were available from this tank, the reliability of these estimates (in either this engineering assessment or the HDW model inventory estimates) are suspect. Although these uncertainties cannot be resolved at this point, some trends can be discussed.

Table D3-4. Comparison of Selected Component Inventory Estimates for Tank 241-SX-104.

| Component | This evaluation (kg) Sludge | This evaluation (kg) Salt cake | This evaluation (kg) | HDW estimated (kg) |
|---|---|---|---|---|
| Bi | <38.4 | 217 | <255 | 476 |
| K | 394 | 3,270 | 3,660 | 4,350 |
| La | NR | 118 | 118 | 9.19 |
| $NO_3$ | 112,000 | 481,000 | 593,000 | 699,000 |
| Mn | 1,210 | 2,020 | 3,230 | 400 |
| $SO_4$ | 1,360 | 40,700 | 42,100 | 44,900 |
| Ni | 108 | 457 | 565 | 2,050 |
| Ca | 244 | 832 | 1,080 | 6,560 |
| Cr | 1,750 | 16,000 | 17,800 | 25,800 |
| $PO_4$ | <1,580 | 100,000 | 102,000 | 15,800 |
| F | <109 | 18,400 | 18,600 | 2,440 |
| Al | 91,100 | 44,500 | 136,000 | 130,000 |
| Fe | 1,470 | 4,810 | 6,280 | 22,200 |
| TOC | 1,580 | 26,400 | 28,000 | 24,800 |
| Na | 89,100 | 537,000 | 626,000 | 568,000 |
| $H_2O$ (percent) | NR | 30.6 | 30.6 | 38.4 |

HDW = Hanford Defined Waste.
NR = Not Reported.

**Manganese.** Potassium permanganate was used in the REDOX process until 1959, thus manganese is expected to be found in tanks containing waste from that process. It is most likely present as highly insoluble manganese dioxide in the alkaline waste materials and would be expected to be in the sludge. The R1 Sludge composition estimate developed in this engineering assessment for Mn was 1,330 $\mu$g/g. Interestingly, the SMMS1 salt cake composition estimate for Mn was 684 $\mu$g/g--much higher than would be expected based on solubility considerations. It should be noted that there are large ranges in both the SMMS1 and R1 data sets for Mn.

The HDW model predicts essentially no Mn in the Sludge (0.8 kg) in tank 241-SX-104 and 148 $\mu$g/g in the salt cake layer. The HDW model inventory estimate for Mn is 400 kg. Based on the discussion above, the 3,230 kg inventory estimate developed in this engineering assessment is likely to be closer to the true value.

**Phosphate.** There is a large difference between the engineering assessment tank inventory estimate (102,000 kg) and the HDW model estimate (15,800 kg). The engineering assessment value is biased high because of one extremely high phosphate value in data set used to develop the SMMS1 salt cake composition estimate (see Table D3-2). If the phosphate data from tank 241-S-102 are eliminated from the SMMS1 composition estimate, then the engineering assessment and the HDW estimate would be in reasonable agreement. However, since the HDW model failed to predict the high phosphate value for 241-S-102, it should not be taken as a reliable indicator for phosphate in tank 241-SX-104.

**Calcium.** The calcium found in tanks containing REDOX waste is believed to have been an impurity in the commercial grade sodium hydroxide used in the neutralization of high-level waste in the process. The calcium value developed in this engineering assessment (1,080 kg) is about one sixth of the HDW model value (6,560 kg). Since many calcium salts of anions such as carbonate, oxalate and phosphate are insoluble and the concentrations of these anions are essentially unknown, it is not surprising that Ca values differ between this engineering assessment and the HDW model.

**Fluoride.** The fluoride ion inventory estimate is about a order of magnitude higher in the engineering assessment (14,200) than in the HDW model (2,440). However, as shown by the data in Table D3-2, the fluoride values in one of the four tanks agree reasonable with the HDW model value. The other three tanks are different than the HDW model. The SMMS analytical data ranges from 500 $\mu$g/g to 13,600 $\mu$g/g. Without analytical data from tank 241-SX-104, it is difficult to defend the choice of one value over the other.

**Iron.** The Fe inventory estimate is about 3.5 times lower in the engineering assessment than in the HDW model. The Fe value determined in the engineering assessment for the salt cake is approximately 6 times the HDW model value. As shown in Table D3-2, the data set used to estimate Fe in the SMMS1 salt cake varies from 3,096 $\mu$g/g to less than the detection limit. Without analytical data from tank 241-SX-104 it is difficult to defend the choice of one value over the other.

**Nickel.** The nickel inventory from the engineering assessment is approximately one-fourth the value of the HDW model inventory. The HDW model predicts the majority of the Ni to be in the sludge, this is were the major differences in the two evaluations is seen. The salt cake engineering assessment value and the SMM modeling from the HDW salt cake estimate agree very well with each other. The HDW model predicts a sludge concentration of 1,420 $\mu$g/g which is more than an order of magnitude greater than the 118 $\mu$g/g predicted in the engineering assessment.

**Total Hydroxide.** Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valence of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, significant figures are retained. This charge balance approach is consistent with that used by Agnew et al. (1997).

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

Key waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage. Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with these activities.

Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW model, process knowledge, and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

As part of this effort, an evaluation of available chemical information for tank 241-SX-104 was performed, including the following:

- The inventory estimate generated by the HDW model (Agnew et al. 1996)
- An engineering evaluation which produced a predicted SMMS1 salt cake inventory and R sludge inventory based on methodology developed by evaluation of similar S and U Tank Farm tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-SX-104 since sampling information is not available. The engineering evaluation inventory was chosen as the best basis for those analytes for which sample-based analytical values were available, from similar S and U Tank Farm tanks, and tank 241-S-104, for the following reasons:

- The sample-based inventory analytical concentrations of the other S and U tanks containing SMMS1 and R waste compared favorably with each other for SMMS1 salt cake and R sludge.
- No methodology is available to fully predict SMMS1 salt cake from process flowsheet or historical records.
- No methodology is available to fully predict R1 waste from process flowsheet or historical records for this tank. REDOX first cycle R1 waste changed composition during the process and accurate records of these changes are not available at this time. Also R1 waste was cascaded and transferred into and out of many S, SX, and U tanks between 1972 and 1978 which makes it hard to predict precipitation.

- For those few analytes where no values were available from the sample-based inventory of similar tanks, the HDW model values were used.

The best-basis inventory for tank 241-SX-104 is presented in Tables D4-1 and D4-2. 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 Estimates for Nonradioactive Components in Tank 241-SX-104 (Effective January 31, 1997).

| Analyte | Total inventory (kg) | Basis (S, M, C, or E)[1] | Comment |
|---|---|---|---|
| Al | 136,000 | E | |
| Bi | <255 | E | |
| Ca | 1,080 | E | |
| Cl | 13,500 | E | |
| TIC as $CO_3$ | 57,400 | M | |
| Cr | 17,800 | E | |
| F | 18,600 | E | |
| Fe | 6,280 | E | |
| Hg | 3.29 | M | |
| K | 3,660 | E | |
| La | 118 | E | |
| Mn | 3,230 | E | |
| Na | 626,000 | E | |
| Ni | 565 | E | |
| $NO_2$ | 197,000 | E | |
| $NO_3$ | 593,000 | E | |
| OH | 373,000 | C | |
| Pb | 596 | E | |
| P as $PO_4$ | 102,000 | E | |
| Si | 7,000 | E | |
| S as $SO_4$ | 42,100 | E | |
| Sr | 403 | E | |
| TOC | 28,000 | E | |
| $U_{TOTAL}$ | 9,700 | E | |
| Zr | 200 | E | |

[1]S = Sample-based
M = Hanford Defined Waste model-based (Agnew et al. 1996)
E = Engineering assessment-based
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 Estimates for Radioactive Components in Tank 241-SX-104, decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

| Analyte | Total inventory (Ci) | Basis (S, M, or E)[1] | Comment |
|---|---|---|---|
| $^{3}H$ | 568 | M | |
| $^{14}C$ | 76.7 | M | |
| $^{59}Ni$ | 12 | M | |
| $^{60}Co$ | 84 | M | |
| $^{63}Ni$ | 1,150 | M | |
| $^{79}Se$ | 9.14 | M | |
| $^{90}Sr$ | 543,000 | E | |
| $^{90}Y$ | 543,000 | E | Based on $^{90}Sr$ |
| $^{93}Zr$ | 44.5 | M | |
| $^{93m}Nb$ | 33.1 | M | |
| $^{99}Tc$ | 548 | M | |
| $^{106}Ru$ | 0.015 | M | |
| $^{113m}Cd$ | 199 | M | |
| $^{125}Sb$ | 359 | M | |
| $^{126}Sn$ | 13.9 | M | |
| $^{129}I$ | 1.03 | M | |
| $^{134}Cs$ | 5.84 | M | |
| $^{137}Cs$ | 522,000 | E | |
| $^{137m}Ba$ | 494,000 | E | Based on $^{137}Cs$ |
| $^{151}Sm$ | 32,300 | M | |
| $^{152}Eu$ | 13.2 | M | |
| $^{154}Eu$ | 1,380 | M | |
| $^{155}Eu$ | 732 | M | |
| $^{226}Ra$ | 8.29 E-04 | M | |
| $^{227}Ac$ | 0.00441 | M | |
| $^{228}Ra$ | 0.289 | M | |
| $^{229}Th$ | 0.00679 | M | |
| $^{231}Pa$ | 0.0118 | M | |

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-SX-104, decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

| Analyte | Total inventory (Ci) | Basis (S, M, or E)[1] | Comment |
|---|---|---|---|
| $^{232}Th$ | 0.0193 | M | |
| $^{232}U$ | 1.49 | M | |
| $^{233}U$ | 5.7 | M | |
| $^{234}U$ | 2.05 | M | |
| $^{235}U$ | 0.0832 | M | |
| $^{236}U$ | 0.0668 | M | |
| $^{237}Np$ | 2.03 | M | |
| $^{238}Pu$ | 6.03 | M | |
| $^{238}U$ | 2.28 | M | |
| $^{239}Pu$ | 296 | M | |
| $^{240}Pu$ | 45.6 | M | |
| $^{241}Am$ | 154 | M | |
| $^{241}Pu$ | 380 | M | |
| $^{242}Cm$ | 0.376 | M | |
| $^{242}Pu$ | 0.00195 | M | |
| $^{243}Am$ | 0.00527 | M | |
| $^{243}Cm$ | 0.0307 | M | |
| $^{244}Cm$ | 0.291 | M | |

[1]S = Sample-based
M = Hanford Defined Waste model-based (Agnew et al. 1997)
E = Engineering assessment-based.

## D5.0 APPENDIX D REFERENCES

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