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Tank Characterization Report for Single-Shell Tank 241-BX-104

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EXECUTIVE SUMMARY

This characterization report summarizes the available information on the historical uses, current status, and sampling and analysis results of waste contained in underground storage tank 241-BX-104. This report supports the requirements of *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-09 (Ecology et al. 1996).

Tank 241-BX-104 is one of twelve single-shell tanks located in the Hanford 200 East Area BX Tank Farm. It is the first tank in a three-tank cascade series with tanks 241-BX-105 and BX-106. Tank 241-BX-104 went into service when it received metal waste from B Plant in January 1949; this waste cascaded into tanks 241-BX-105 and BX-106 until all three were filled in January 1950. The metal waste was transferred out for uranium recovery operations from late 1954 until early 1955. Tributyl phosphate waste was received in the second quarter of 1956, and supernatant was transferred out during the first quarter of 1957, nearly emptying the tank. Beginning in late 1962 with the receipt of plutonium-uranium extraction (PUREX process) cladding waste, the tank had a very active process history for the following 18 years. The tank received a number of different waste types, including cesium recovery operations waste, cesium recovery ion exchange waste, reduction-oxidation (REDOX process) high-level waste, B Plant low-level waste, evaporator waste from the in-tank solidification process, and strontium recovery supernatant. A transfer of supernatant waste out of the tank in the fourth quarter of 1980 completed the process history, although saltwell pumping occurred during the fourth quarter of 1983.

A description of tank 241-BX-104 and its status are presented in Table ES-1, and a plan view schematic and profile are provided in Figure ES-1. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 375 kL (99 kgal) of non-complexed waste. Of this total volume, 11 kL (3 kgal) are estimated to be supernatant, and 363 kL (96 kgal) are predicted to be sludge. The sludge contains an estimated 114 kL (30 kgal) of drainable interstitial liquid (Hanlon 1996).

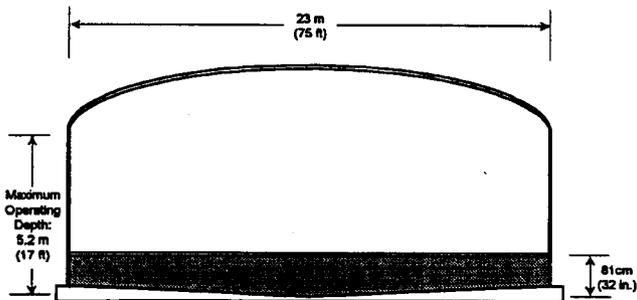
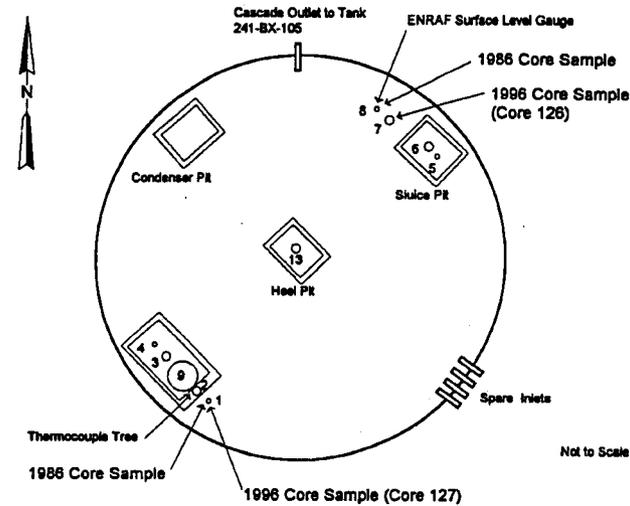
Table ES-1. Description and Status of Tank 241-BX-104.

| TANK DESCRIPTION | | |
|---|--|---------------------------------|
| Type | | Single-shell |
| Constructed | | 1946-1947 |
| In-service | | January 1949 |
| Diameter | | 22.9 m (75.0 ft) |
| Operating depth | | 5.2 m (17 ft) |
| Capacity | | 2,010 kL (530 kgal) |
| Bottom shape | | Dish |
| Ventilation | | Passive |
| TANK STATUS | | |
| Waste classification | | Non-complexed |
| Total waste volume | | 375 kL (99 kgal) |
| Sludge volume | | 363 kL (96 kgal) |
| Supernatant volume | | 11 kL (3 kgal) |
| Waste surface level (March 1996) | | 81 cm (32 in.) |
| Temperature ¹ (September 1974 to October 1980) | | 18 °C (64 °F) to 51 °C (124 °F) |
| Integrity | | Sound |
| Watch List | | None |
| SAMPLING DATES | | |
| Vapor sampling | | December 1994 |
| Push mode core samples and tank headspace flammability | | January 1996 |
| SERVICE STATUS | | |
| Declared inactive | | November 1980 |
| Interim stabilization | | September 1989 |
| Intrusion prevention | | September 1989 |

Note:

¹No temperature measurements have been taken since 1980.

Figure ES-1. Profile of Tank 241-BX-104.



Total Tank Volume: 2,010 kL (530 kgal)
 Waste Volume (February 1996): 375 kL (99 kgal)
 Sludge Volume (February 1996): 363 kL (96 kgal)
 Supernate Volume (February 1996): 11 kL (3 kgal)

Not to Scale

This report summarizes the collection and analysis of two push-mode core samples acquired in January 1996 and reported in *Final Report for Tank 241-BX-104, Push Mode Cores 126 and 127* (Hu 1996). Core 126 was obtained from riser 7 and core 127 was obtained from riser 1. The sampling event was performed to satisfy the requirements listed in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The sampling and analyses were performed in accordance with *Tank 241-BX-104 Push Mode Core Sampling and Analysis Plan* (Gretsinger 1996). This report also summarizes the results from the December 1994 vapor sampling event. The headspace gas and vapor samples were collected and analyzed to satisfy data quality objectives for generic in-tank health and safety issue resolution (Osborne et al. 1994).

The Safety Screening data quality objective (DQO) requires analyses for fuel content using differential scanning calorimetry (DSC), weight percent (wt%) water by thermogravimetric analysis (TGA), total alpha activity through alpha proportional counting, bulk density measurement by centrifugation, and a visual examination of all liquid samples for the presence of an organic layer. The Safety Screening DQO also requires a determination of the flammability of the tank headspace gases. To satisfy this requirement, vapor samples were taken prior to and during core sampling, and flammability was measured as a percentage of the lower flammability limit (LFL) using a combustible gas meter. The Organic Complexant Safety DQO also required analyses for fuel content and wt% water, as well as for total organic carbon (TOC) to evaluate its contribution to the total fuel content.

Table ES-2 provides concentration and inventory estimates for the most prevalent analytes and analytes of concern based on the 1996 core sampling analyses (Hu 1996).

Table ES-2. Major Analytes and Analytes of Concern.¹ (2 sheets)

| Analyte | Sludge ² | | | Drainable Liquid ³ | | |
|------------------------|---------------------|------------|---------------------|-------------------------------|------------|---------------------|
| | Overall Mean | RSD (Mean) | Projected Inventory | Overall Mean | RSD (Mean) | Projected Inventory |
| METALS | $\mu\text{g/g}$ | % | kg | $\mu\text{g/mL}$ | % | kg |
| Aluminum | 1.15E+05 | 57.1 | 67,700 | 2,840 | 1.1 | 98.0 |
| Chromium | 6,330 | 63.6 | 3,730 | 2,970 | 12.1 | 102 |
| Iron | 6,400 | 57.2 | 3,770 | \approx 2.05 | 2.4 | \approx 0.0707 |
| Phosphorus | \approx 2,340 | 34.9 | \approx 1,380 | 1,780 | 10.8 | 61.4 |
| Selenium | \approx 1,040 | 22.1 | \approx 613 | < 16.3 | N/A | < 0.56 |
| Sodium | 72,700 | 30.6 | 42,800 | 140,000 | 0.8 | 4,830 |
| Uranium | 38,400 | 42.5 | 22,600 | < 65.0 | N/A | < 2.24 |
| ANIONS | $\mu\text{g/g}$ | % | kg | $\mu\text{g/mL}$ | % | kg |
| Chloride | 1,040 | 17.7 | 613 | 2,800 | 3.6 | 96.6 |
| Nitrate | 47,800 | 22.4 | 28,200 | 1.35E+05 | 12.3 | 4,660 |
| Nitrite | 24,200 | 28.5 | 14,300 | 63,800 | 5.9 | 2,200 |
| Phosphate | 8,490 | 54.9 | 5,000 | 4,780 | 3.7 | 165 |
| Sulfate | 1,750 | 21.2 | 1,030 | 3,930 | 4.5 | 136 |
| RADIONUCLIDES | $\mu\text{Ci/g}$ | % | Cl | $\mu\text{Ci/g}$ | % | Cl |
| Total alpha | 1.28 | 71.8 | 754 | 2.63E-04 | 58.2 | 0.0117 |
| ¹³⁷ Cs | 73.1 | 3.7 | 43,100 | N/A | N/A | N/A |
| CARBON | $\mu\text{g C/g}$ | % | kg C | $\mu\text{g C/mL}$ | % | kg C |
| Total inorganic carbon | 4,830 | 35.4 | 2,840 | 8,950 | 12.9 | 309 |
| Total organic carbon | 5,210 | 42.1 | 3,070 | 3,190 | 31.3 | 110 |

Table ES-2. Major Analytes and Analytes of Concern.¹ (2 sheets)

| Analyte | Sludge ² | | | Drainable Liquid ¹ | | |
|----------------------------|---------------------|------------|---------------------|-------------------------------|------------|---------------------|
| | Overall Mean | RSD (Mean) | Projected Inventory | Overall Mean | RSD (Mean) | Projected Inventory |
| PHYSICAL PROPERTIES | | | | | | |
| Water | 29.5 wt % | 51.7 | 174,000 kg | 59.1 wt % | 1.1 | 26,300 kg |
| Density | 1.73 g/mL | 11.8 | N/A | 1.29 g/mL | 0.4 | N/A |

Notes:

N/A = Not applicable

NR = Not reported

Values following a '~' symbol were reported by the laboratory as estimated.

¹Hu (1996)²The inventory basis for the calculation are 5.887E+08 g and 3.45E+07 mL for sludge and drainable liquid, respectively.

Comparisons were made between the analytical results and the decision criteria thresholds defined in the Safety Screening and Organic Complexant Safety DQOs. The results given below for DSC and TOC are on a dry weight basis. Several exothermic reactions were observed during the DSC analysis. The measured heat transfer ranged from -8.8 J/g to -74 J/g. The highest upper limits of a one-sided 95 percent upper confidence interval of the exotherm were -45.0 J/g and -174 J/g for sludge and drainable liquid, respectively. These and all other DSC results were below the decision threshold of -480 J/g.

The measurements of TOC in the sludge ranged from 771 $\mu\text{g C/g}$ to 16,692 $\mu\text{g C/g}$ with a mean of 6,213 $\mu\text{g C/g}$. The drainable liquid values ranged from 4,172 $\mu\text{g C/g}$ to 8,082 $\mu\text{g C/g}$ with an overall mean of 5,830 $\mu\text{g C/g}$. The highest upper limits of a one-sided 95 percent confidence interval were 23,028 $\mu\text{g C/g}$ and 9,098 $\mu\text{g C/g}$ for sludge and drainable liquid, respectively. All results were below the TOC decision thresholds of

30,000 $\mu\text{g C/g}$ (3 wt%). No separable organic layer was observed in any of the drainable liquid samples. In the sludge portion of the waste, two sample means for wt% water were below the Organic Complexant Safety DQO decision threshold of 17 percent. However, secondary analyses are required only if both the fuel and moisture decision limits are exceeded for a given sample. The overall sludge mean of total alpha activity was 1.28 $\mu\text{Ci/g}$; the highest upper limit of a one-sided 95 percent confidence interval was 2.53 $\mu\text{Ci/g}$. All these values are more than a factor of 10 less than the notification limits. For drainable liquid, all total alpha activity were several orders of magnitude below the safety screening decision thresholds. The concentration of flammable gases in the tank headspace was 0 percent of the LFL, well below the decision threshold of ≤ 25 percent of the LFL.

Because of the lack of radionuclide data from the 1996 sampling event, the tank heat load produced by radioactive decay could not be calculated. However, estimates from two other sources were available. The heat load based on *Hanford Tank Chemical and Radionuclide Inventories, HDW Model Rev. 3* (Agnew et al. 1996a) was 362 W (1,230 Btu/hr), while the estimate derived from the headspace temperature was 6,208 W (21,200 Btu/hr) (Kummerer 1994). Both estimates were below the 11,700-W (40,000-Btu/hr) design specification threshold (Bergmann 1991). Between September 1974 and October 1980 the minimum temperature was 18 °C (64 °F) and the maximum temperature was 51 °C (124 °F). Because the tank exhibits a peak annual temperature, it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

Hydrostatic head fluid (HHF) was used during the core sampling operations. There was evidence that over 50 percent of the moisture content in the samples from segment 2, core 127 was HHF contaminated. This contamination will impact the value of wt% water, TOC, bulk density and soluble material concentration. The data from this segment were not included in the calculation of the overall tank means. The contamination has no impact in the safety evaluation because the DSC and TOC values were evaluated on a dry weight basis, and the contaminated sample will give the conservative upper limit to compare with the DQO's threshold.

In summary, all analytical results and one-sided 95 percent confidence interval limits were within the criteria listed in the Safety Screening and Organic Complexant Safety DQOs. The data indicated that the tank is "SAFE" with respect to the Safety Screening and Organic Complexant Safety DQO criteria.

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LIST OF TERMS

| | |
|--------|---|
| ANOVA | analysis of variance |
| BL | B Plant low level waste |
| Btu/hr | British thermal units per hour |
| CLPX | complexed waste |
| c/s | counts per second |
| CSR | cesium recovery waste |
| CWP | PUREX cladding waste |
| Ci | curies |
| Ci/g | curies per gram |
| Ci/L | curies per liter |
| cm | centimeters |
| DL | drainable liquid |
| DSSF | double-shell slurry feed |
| DQO | data quality objective |
| DSC | differential scanning calorimetry |
| ft | feet |
| g | grams |
| g/cc | grams per cubic centimeter |
| g/gal | grams per gallon |
| g/L | grams per liter |
| g/mL | grams per milliliter |
| GEA | gamma energy analysis |
| HDW | Hanford Defined Waste |
| HHF | hydrostatic head fluid |
| HTCE | historical tank content estimate |
| in. | inches |
| IC | ion chromatography |
| ICP | inductively coupled plasma spectroscopy |
| ITS | in-tank solidification |
| IX | cesium recovery ion exchange waste |
| J/g | joules per gram |
| kg | kilograms |
| kgal | kilogallons |
| kL | kiloliters |
| kW | kilowatts |
| LFL | lower flammability limit |
| m | meters |
| M | moles per liter |
| mL | milliliters |
| mm | millimeters |

LIST OF TERMS (Continued)

| | |
|---------|---|
| mole/L | moles per liter |
| mrad | millirads |
| mR/hr | milliroentgen per hour |
| NCPLX | non-complexed waste |
| ORNL | Oak Ridge National Laboratory |
| PNNL | Pacific Northwest National Laboratory |
| ppm | parts per million |
| ppmv | parts per million by volume |
| PUREX | plutonium-uranium extraction |
| R | REDOX high-level waste |
| rad/hr | rads per hour |
| REDOX | reduction-oxidation |
| QC | quality control |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SACS | Surveillance Analysis Computer System |
| SAP | sampling and analysis plan |
| SMM | supernatant mixing model |
| SRS | strontium recovery supernatant |
| TC | total carbon |
| TGA | thermogravimetric analysis |
| TIC | total inorganic carbon |
| TLM | Tank Layer Model |
| TOC | total organic carbon |
| WVR | waste volume reduction |
| W | watts |
| WSTRS | Waste Status and Transaction Record Summary |
| wt% | weight percent |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| μg C/g | micrograms carbon per gram |
| μg C/mL | micrograms carbon per hour |
| μCi/g | microcuries per gram |
| μCi/L | microcuries per liter |
| μeq/g | microequivalents per gram |
| μg/g | micrograms per gram |
| μg/mL | micrograms per milliliter |
| μm | micrometer |

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1.0 INTRODUCTION

This tank characterization report presents an overview of single-shell tank 241-BX-104 and its waste contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities, in combination with background tank information. The characterization of tank 241-BX-104 is based on the results of two push-mode core samples taken in January 1996. The sampling and analysis event was driven by *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), and *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995). The integrated requirements for analyses and decision criteria thresholds for the two data quality objectives (DQOs) can be found in *Tank 241-BX-104 Push-mode Core Sampling and Analysis Plan* (Gretsinger 1996). The organic safety program has requested that the tank be sampled as if it were on the Organic Watch List, although it is not. For informational purposes, results from a 1994 vapor sampling event and a 1986 sludge sampling event are also presented.

Tank 241-BX-104 was removed from service in 1980 and interim stabilized in 1989. Consequently, the composition of the waste should not change appreciably until pretreatment and retrieval activities commence. The analyte concentrations reported in this document reflect the best available estimates of the current tank contents based on the analytical data and historical models. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-09 (Ecology et al. 1996).

1.1 PURPOSE

The purpose of this report is to summarize the information about the use and contents of tank 241-BX-104. Where possible, this information will be used to assess issues associated with safety, operations, environmental, and process development activities. This report also serves as a reference point for more detailed information concerning tank 241-BX-104.

1.2 SCOPE

In accordance with the requirements of Gretsing (1996), the following analyses were performed: differential scanning calorimetry (DSC) to evaluate fuel level and energetics; thermogravimetric analysis (TGA) to determine moisture content; total alpha activity analysis to evaluate criticality potential; inductively coupled plasma spectroscopy (ICP) for lithium and the principal cations; ion chromatography (IC) for bromide and the principal anions; persulfate oxidation and coulometry for total organic carbon (TOC); gamma energy analysis (GEA) for ¹³⁷Cs as part of a check on homogenization procedures; density; and a visual

check for an organic layer. Other analyses were performed on an opportunistic basis in accordance with Kristofzski (1995). In addition to these analyses conducted on the core samples, the tank headspace was sampled for the presence of flammable gases in accordance with the Safety Screening DQO.

2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-BX-104 based on historical information. The first part details the current condition of the tank. The next part contains a discussion of the tank's design, transfer history, and the process sources that contributed to the tank waste, including an estimate of the current contents based on the process history. Conditions that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperatures, are included. The final part summarizes available surveillance data for the tank. Solid and liquid level data are used to determine tank integrity (leaks) and to provide clues to internal activity in the solid layers of the tank. Temperature data are provided to evaluate the heat-generating characteristics of the waste.

2.1 TANK STATUS

As of February 29, 1996, tank 241-BX-104 contained an estimated 375 kL (99 kgal) of non-complexed waste (Hanlon 1996). Liquid and solids waste volumes were calculated using a surface level gauge. Solid waste volume was last updated on September 22, 1989. The amounts of various waste phases existing in the tank are presented in Table 2-1.

Table 2-1. Calculated Tank Contents.¹

| Waste Form | Calculated Volume | |
|-------------------------------|-------------------|------|
| | kL | kgal |
| Total waste | 375 | 99 |
| Supernatant liquid | 11 | 3 |
| Sludge | 363 | 96 |
| Saltcake | 0 | 0 |
| Drainable interstitial liquid | 114 | 30 |
| Drainable liquid remaining | 125 | 33 |
| Pumpable liquid remaining | 102 | 27 |

Note:

¹For definitions and calculation methods, refer to Appendix C of Hanlon (1996).

Tank 241-BX-104 is categorized as sound, with interim stabilization and intrusion prevention completed. This tank is passively ventilated. As of February 29, 1996, all monitoring systems (except the thermocouple tree, which was out of service) were in compliance with documented standards (Hanlon 1996).

2.2 TANK DESIGN AND BACKGROUND

The 241-BX Tank Farm was constructed between 1946 and 1947 in the 200 East Area. The 241-BX Tank Farm contains 12 100-series tanks with 2,006-kL (530-kgal) capacities, 22.86-m (75-ft) diameters, and 5.18-m (17-ft) operating depths. The 241-BX Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F).

Tank 241-BX-104 began receiving waste in January 1949. A cascade overflow line 76 mm (3 in.) in diameter connects tank 241-BX-104 (first in the cascade series) with tanks 241-BX-105 and BX-106; waste then cascades into tank 241-BY-104. Each tank in the cascade series is set 30 cm (1 ft) lower in elevation from the preceding tank. The cascade overflow height is approximately 4.9 m (16 ft) from the tank bottom and 600 mm (2 ft) below the top of the steel liner.

The tank has a dished bottom with a 1.2-m (4-ft)-radius knuckle. It was designed with a primary mild steel liner (ASTM A283 Grade C) and a concrete dome with various risers. The tank is set on a reinforced concrete foundation. Three-ply asphalt waterproofing was applied over the foundation and steel tank. Two coats of primer were sprayed on all exposed interior tank surfaces. The tank ceiling dome was covered with three applications of magnesium zincfluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the manholes in the tank dome. The tank was waterproofed on the sides and top with tar and welded-wire reinforced cement, and covered with approximately 2.1 m (7 ft) of overburden.

Tank 241-BX-104 has 10 risers ranging in diameter from 100 mm (4 in.) to 1.1 m (42 in.). A plan view that depicts the riser configuration is shown as Figure 2-1. Risers 1 and 7, 100 mm (4 in.) and 300 mm (12 in.) in diameter, respectively, are available for use. Table 2-2 shows numbers, diameters, and descriptions of the risers and the inlet, overflow, and spare nozzles. A tank cross-section showing the approximate waste level along with a schematic of the tank equipment is in Figure 2-2.

Figure 2-1. Riser Configuration for Tank 241-BX-104.

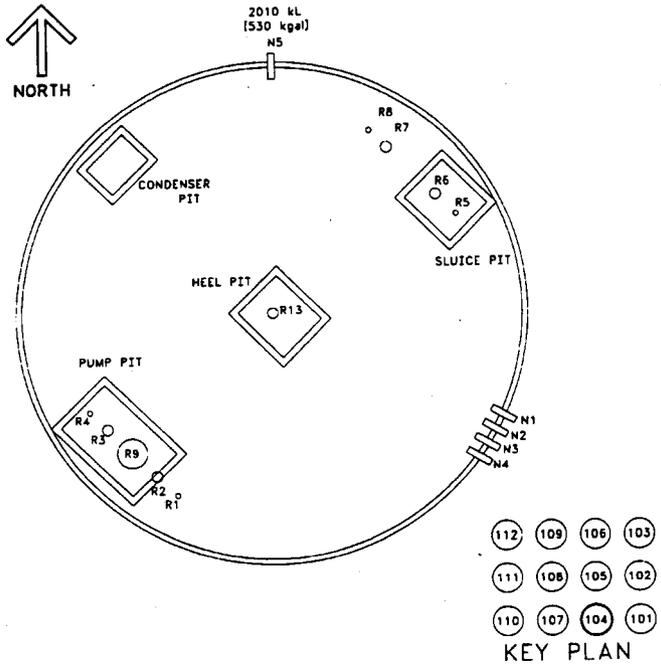


Figure 2-2. Tank 241-BX-104 Cross-Section.

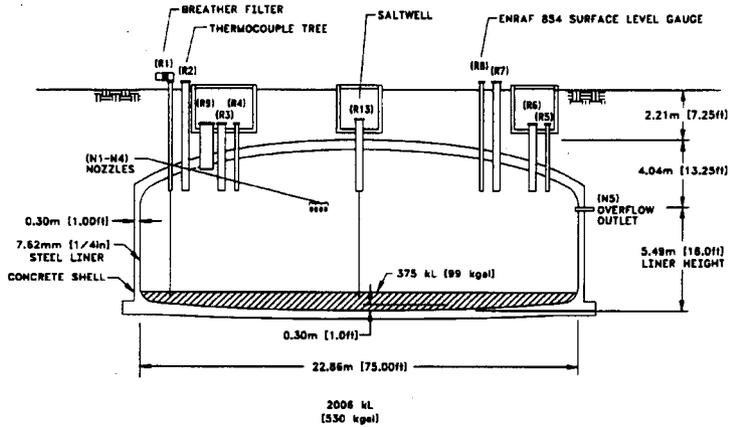


Table 2-2. Tank 241-BX-104 Risers.^{1,2,3}

| Riser Number | Diameter (in.) | Description and Comments |
|---------------|----------------|--|
| 1 | 4 | Breather filter, G1 housing, benchmark |
| 2 | 12 | Thermocouple tree |
| 3 | 12 | Sluicing nozzle (weather covered) |
| 4 | 4 | Recirculating dip tube (weather covered) |
| 5 | 4 | Recirculating dip tube (weather covered) |
| 6 | 12 | Sluicing nozzle (weather covered) |
| 7 | 12 | Observation port |
| 8 | 4 | ENRAF ¹ 854 surface level gauge (benchmark) |
| 9 | 42 | Sludge pump (weather covered) |
| 13 | 12 | Saltwell pump |
| Nozzle Number | Diameter (in.) | Description and Comments |
| N1 | 3 | Spare |
| N2 | 3 | Spare |
| N3 | 3 | Spare |
| N4 | 3 | Spare |
| N5 | 3 | Overflow outlet |

Notes:

¹Alstad (1993)

²Tran (1993)

³Vitro Engineering Corporation (1988)

2.3 PROCESS KNOWLEDGE

Section 2.3.1 and Table 2-3 present the history of the major transfers that involved tank 241-BX-104 receiving waste along with a narrative describing these transfers. Section 2.3.2 presents an estimate of the tank's contents.

¹Trademark of ENRAF Corporation, Houston, Texas.

2.3.1 Waste Transfer History

Tank 241-BX-104 first received metal waste 1 (defined in Agnew 1995) in January 1949 from B Plant. The tank cascaded metal waste 1 to tanks 241-BX-105 and BX-106 until the entire cascade was filled in January 1950. In January 1951, the BX Tank Farm cascade series cascaded waste to the BY Tank Farm through tank 241-BY-104.

Table 2-3. Summary of Tank 241-BX-104 Waste Receipt History.^{1,2} (2 sheets)

| Transfer Source | Waste Type Received | Time Period | Estimated Waste Volume | |
|--|--|----------------------|------------------------|-------|
| | | | kL | kgal |
| B Plant | Metal waste from BiPO ₄ process | 1949 - 1951 | 10,762 | 2,843 |
| 241-BY-110 | Transfer of supernatant tri-butyl phosphate waste | 1956 | 1,885 | 498 |
| 241-C-102 | Transfer of CWP supernatant | 1962 | 1,772 | 468 |
| 241-C-108 | Transfer of CWP supernatant | 1964 | 45 | 12 |
| B Plant | Waste from cesium recovery operations | 1967 - 1969 | 11,810 | 3,120 |
| 241-BY-112 | Transfer of cladding waste | 1968 | 961 | 254 |
| 241-BX-106, 241-BX-110, 241-BX-111, 241-C-110 | Transfer of supernatant ion exchange waste from cesium recovery operations | 1970 | 4,626 | 1,222 |
| 241-SX-103 | Transfer of REDOX high-level waste supernatant | 1971 | 1,923 | 508 |
| 241-SX-102 | Transfer of REDOX high-level waste supernatant | 1971 - 1972 | 14,086 | 3,721 |
| 241-BX-101 | Transfer of supernatant Ion Exchange waste from Cesium Recovery operations | 1971, 1974 - 1976 | 1,552 | 410 |
| 241-B-101 | Transfer of B Plant low-level waste supernatant | 1972 - 1973 | 2,585 | 683 |

Table 2-3. Summary of Tank 241-BX-104 Waste Receipt History.^{1,2} (2 sheets)

| Transfer Source | Waste Type Received | Time Period | Estimated Waste Volume | |
|-----------------------|---|-------------|------------------------|-------|
| | | | kL | kgal |
| B Plant | Waste from cesium recovery operations | 1972 - 1976 | 21,157 | 5,589 |
| 241-BX-101 | B Plant low-level waste | 1974 - 1976 | 454 | 120 |
| BY-ITS#1 and BY-ITS#2 | Evaporator bottoms saltcake | 1976 | 1,173 | 310 |
| 241-A-102 | Transfer of evaporator feed waste supernatant | 1976 - 1977 | 980 | 259 |
| 241-C-103 | Transfer of SRS waste | 1978 | 1,579 | 417 |
| 241-A-102, 241-BX-105 | Transfer of evaporator feed waste supernatant | 1978 - 1980 | 24,798 | 6,551 |

Notes:

¹Waste volumes and types are best estimates based on historical data. Because of the lack of QC procedures, estimates based on historical data may not be reliable and should be used with caution.

²Agnew et al. (1996b)

CWP = plutonium-uranium extraction (PUREX) cladding waste
 REDOX = reduction-oxidation
 SRS = strontium recovery supernatant

In the third quarter of 1954 and the first quarter of 1955, waste from tank 241-BX-104 was transferred to the 221-U Building for uranium recovery operations. In the second quarter of 1956, tank 241-BX-104 received supernatant uranium recovery waste (tri-butyl phosphate waste) from tank 241-BY-110. Supernatant from tank 241-BX-104 was sent to crib B-026 during the first quarter of 1957, almost emptying the tank.

Tank 241-BX-104 was inactive until the fourth quarter of 1962, when it was filled with plutonium-uranium extraction (PUREX) cladding waste (CWP) from tank 241-C-102. Cladding waste from tank 241-C-108 was transferred to tank 241-BX-104 in the second quarter of 1964.

Cesium recovery operations (CSR) waste from B Plant was added to tank 241-BX-104 during the fourth quarter of 1967. Also during this time, supernatant waste held in the tank was sent to tank 241-BY-103. The CSR waste continued to be added to the tank until the third quarter of 1969. B Plant cell 23 waste from tank 241-BY-112 was sent to tank 241-BX-104 during the first quarter of 1968. Waste from tank 241-BX-104 was sent to the following tanks (year and quarter in parentheses): 241-BX-105 (1968-4); BX-106 (1968-1, 1969-1);

BX-107 (1969-3); BX-108 (1969-2); BX-111 (1969-2, 1969-3); BY-102 (1969-3); BY-104 (1968-2, 1968-3).

During the second quarter of 1970, tank 241-BX-104 received cesium recovery ion exchange (IX) waste from tanks 241-BX-106 and BX-110 and transferred waste to tank 241-C-110. In the third quarter of 1970, the tank received IX waste from tank 241-BX-111 and sent waste to tanks 241-B-102, 241-C-107, and 241-C-110.

From the first quarter of 1971 until the second quarter of 1972, tank 241-BX-104 sent waste to the CSR in B Plant. During the first and second quarters of 1971, the tank received REDOX high-level (R) waste from tank 241-SX-103. Tank 241-SX-102 sent R waste to tank 241-BX-104 during the second, third, and fourth quarters of 1971. The tank received IX waste from tank 241-BX-101 during the second quarter of 1971. The addition of R waste from tank 241-SX-102 continued until the second quarter of 1972.

During the fourth quarter of 1972, tank 241-BX-104 received CSR waste and B Plant low-level (BL) waste from tanks 241-BX-101 and 241-B-101, respectively, and sent waste to tanks 241-C-105 and 241-T-105. Tank 241-B-101 continued to send BL waste to tank 241-BX-104 until the first quarter of 1973. From the fourth quarter of 1972 until the second quarter of 1976, CSR waste was added to the tank. During the second and third quarters of 1974 and 1975 and the first and second quarters of 1976, BL waste was transferred to tank 241-BX-104 from tank 241-BX-101. Tank 241-BX-104 sent and received evaporator waste from the in-tank solidification (ITS) process during the first quarter of 1976. The tank transferred waste, from the fourth quarter of 1972 until the second quarter of 1976, to the following tanks (years and quarter in parentheses): 241-B-103 (1973-2); BX-103 (1975-2,3,4; 1976-1,2); BX-105 (1973-2); C-105 (1972-4); S-107 (1974-4, 1975-1); S-110 (1974-1); T-105 (1972-4, 1973-1); T-107 (1973-1,2); TX-101 (1972-4, 1973-1).

From the third quarter of 1976 to the fourth quarter of 1980, tank 241-BX-104 provided a transfer connection for tank 241-A-102 and the 242-A Evaporator. Tank 241-A-102 was the feed tank for the 242-A Evaporator during this time period. Tank 241-BX-104 received strontium recovery supernatant (SRS) waste from tank 241-C-103 during the first quarter of 1978. From the third quarter of 1978 to the third quarter of 1980, tank 241-BX-105 sent waste to tank 241-BX-104, which was then transferred to tanks 241-A-101 and 241-A-102. The classification of the waste in tank 241-BX-104 changed from non-complexed waste (NCPLX) in the fourth quarter of 1978 to double-shell slurry feed (DSSF) in the second quarter of 1979. The waste classification was changed to complexed waste (CPLX) in the second quarter of 1979 and to DSSF in the third quarter of 1980. Presently, the waste in tank 241-BX-104 is classified as NCLPX.

A transfer of supernatant waste from tank 241-BX-104 to double-shell tanks 241-AY-102 and 241-AZ-101 occurred during the fourth quarter of 1980. The tank was labeled inactive on November 17, 1980. The final transfer involving tank 241-BX-104 was saltwell pumping to tank 241-AN-101 during the fourth quarter of 1983.

2.3.2 Historical Estimation of Tank Contents

The following is an estimate of the contents in tank 241-BX-104 based on historical transfer data. The historical data used for the estimate are the *Waste Status and Transaction Record Summary for the Northeast Quadrant* (WSTRS) (Agnew et al. 1996b), *Hanford Defined Wastes: Chemical and Radionuclide Compositions* (HDW) (Agnew 1995), *Tank Layer Model (TLM) for Northeast, Southwest, and Northwest Quadrants* (Agnew et al. 1995), and *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). The WSTRS is a compilation of available waste transfer and volume status data. The HDW provides the assumed typical compositions for 50 separate waste types. In most cases, the available data are incomplete, reducing the reliability of the transfer data and the derived modeling results. The TLM, using the WSTRS data, models the waste deposition processes and (using additional composition data from the HDW, which may introduce more error bias) generates an estimate of the tank contents. Thus, these model predictions are considered estimates that require further evaluation using analytical data.

Based on the historical tank content estimate (HTCE) and the TLM, tank 241-BX-104 contains an 11-kL (3-kgal) top layer of supernatant waste, a 208-kL (55-kgal) layer of unknown solids waste, and a 155-kL (41-kgal) bottom layer of metal waste. A graphical representation of the estimated waste types and volumes for these layers can be seen in Figure 2-3. The metal waste 1 layer should contain large amounts of sodium, iron, hydroxide, carbonate, phosphate, nitrate, sulphate, and uranium. Additionally, chromium, calcium, nickel, nitrite, chloride, silicate, and a trace of plutonium will be found. Also present will be small quantities of strontium and cesium; therefore, this layer will have a small amount of radioactivity. The specifics on the supernatant and unknown waste layers are not well defined. The unknown layer could be settled solids from the CSR waste added to the tank during the mid 1970s. This is supported by the WSTRS cumulative unknowns increasing during the time period corresponding to the addition of CSR waste to the tank. Table 2-4 shows an estimate of the expected waste constituents and their concentrations.

2.4 SURVEILLANCE DATA

Tank 241-BX-104 surveillance consists of surface level measurements (liquid and solid) and temperature monitoring inside the tank (waste and headspace). The data provide the basis for determining tank integrity.

Liquid level measurements may indicate if a tank has a major leak. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers of a tank. Drywells located around the perimeter of the tank may show signs of increased radiation as a result of a leak. Tank BX-104 is categorized as sound, and is interim stabilized with intrusion prevention completed.

Table 2-4. Tank 241-BX-104 Inventory Estimate¹ (Agnew et al. 1996a)². (2 sheets)

| Total Inventory Estimate | | | |
|-------------------------------|----------------------------|----------|----------|
| Physical Properties | | | |
| Total waste | 5.80E+05 kg (99.0 kgal) | | |
| Heat load | 0.362 kW (1.23E+03 Btu/hr) | | |
| Bulk density | 1.55 (g/cc) | | |
| Water wt% | 46.3 | | |
| Total Organic Carbon | 0.537 | | |
| Chemical Constituents | mole/L | ppm | kg |
| Na ⁺ | 7.26 | 1.08E+05 | 6.25E+04 |
| Al ³⁺ | 0.671 | 1.17E+04 | 6.79E+03 |
| Fe ³⁺ (total Fe) | 5.26E-02 | 1.89E+03 | 1.10E+03 |
| Cr ³⁺ | 2.57E-02 | 864 | 501 |
| Bi ³⁺ | 5.46E-04 | 73.6 | 42.7 |
| La ³⁺ | 1.68E-05 | 1.50 | 0.872 |
| Hg ²⁺ | 3.74E-06 | 0.485 | 0.281 |
| Zr (as ZrO(OH) ₂) | 3.76E-04 | 22.2 | 12.9 |
| Pb ²⁺ | 4.13E-04 | 55.2 | 32.0 |
| Ni ²⁺ | 3.11E-03 | 118 | 68.4 |
| Sr ²⁺ | 5.59E-06 | 0.316 | 0.183 |
| Mn ⁴⁺ | 1.75E-03 | 61.9 | 35.9 |
| Ca ²⁺ | 5.03E-02 | 1.30E+03 | 756 |
| K ¹⁺ | 2.46E-02 | 621 | 360 |
| OH ⁻ | 8.03 | 8.82E+04 | 5.12E+04 |
| NO ₃ ⁻ | 2.26 | 9.05E+04 | 5.25E+04 |
| NO ₂ ⁻ | 1.01 | 3.00E+04 | 1.74E+04 |
| CO ₃ ²⁻ | 0.992 | 3.84E+04 | 2.23E+04 |
| PO ₄ ³⁻ | 0.205 | 1.26E+04 | 7.31E+03 |
| SO ₄ ²⁻ | 0.145 | 9.02E+03 | 5.24E+03 |

Table 2-4. Tank 241-BX-104 Inventory Estimate¹ (Agnew et al. 1996a)². (2 sheets)

| Chemical Constituents | mole/l | ppm | kg |
|--|-----------------|------------------|---------------|
| Si (as SiO ₃ ²⁻) | 3.77E-02 | 685 | 397 |
| F ⁻ | 3.08E-02 | 378 | 219 |
| Cl ⁻ | 9.20E-02 | 2.10E+03 | 1.22E+03 |
| C ₆ H ₅ O ₇ ³⁻ | 1.29E-02 | 1.57E+03 | 914 |
| EDTA ⁴⁻ | 1.34E-02 | 2.49E+03 | 1.45E+03 |
| HEDTA ³⁻ | 2.59E-02 | 4.58E+03 | 2.66E+03 |
| glycolate ⁻ | 5.85E-02 | 2.83E+03 | 1.64E+03 |
| acetate ⁻ | 3.00E-03 | 114 | 66.4 |
| oxalate ²⁻ | 1.43E-05 | 0.815 | 0.473 |
| DBP | 8.31E-03 | 1.43E+03 | 828 |
| Butanol | 8.31E-03 | 398 | 231 |
| NH ₃ | 2.45E-02 | 269 | 156 |
| Fe(CN) ₆ ⁴⁻ | 0 | 0 | 0 |
| Radiological | | | |
| Pu | | 2.62E-02 (μCi/g) | 0.254 (kg) |
| U | 0.829 (M) | 1.27E+05 (μg/g) | 7.39E+04 (kg) |
| Cs | 0.119 (Ci/L) | 76.9 (μCi/g) | 4.46E+04 (Ci) |
| Sr | 6.04E-02 (Ci/L) | 39.0 (μCi/g) | 2.26E+04 (Ci) |

Notes:

¹The estimate predictions have not been validated and should be used with caution.

²Differences appear to exist between the inventory above and the inventories calculated from the two sets of concentrations. These differences are being evaluated.

2.4.1 Surface Level

The surface level of the waste is monitored with an ENRAF™ 854 surface level gauge through riser 8. The ENRAF™ gauge replaced the Food Instrument Corporation level gauge in November 1994. The maximum allowed deviations from the 798 mm (31.4 in.) baseline established for tank 241-BX-104 are a 50-mm (2-in.) increase and a 50-mm (2-in.) decrease. The surface level reading on March 11, 1996 was 812 mm (32 in.). A graphical representation of the tank volume history is presented in Figure 2-4.

2.4.2 Drywells

Tank 241-BX-104 has six drywells. Drywells 21-04-08 and 21-04-11 had readings greater than the 50-c/s background radiation. Drywell data for tank 241-BX-104 can be found in Brevick et al. (1994).

2.4.3 Internal Tank Temperatures

Tank 241-BX-104 has a single thermocouple tree with 14 thermocouples to monitor the waste temperature. The design of the thermocouple tree in this tank is not documented; thus, the elevations of the individual thermocouples are unknown. Temperature data, obtained from the Surveillance Analysis Computer System (SACS), were recorded from September 1974 until October 1980. The thermocouple tree has been out of service since December 1980; therefore, no data after this date exist. The mean temperature of the SACS data was 24 °C (76 °F) with a minimum of -7.8 °C (18 °F) and a maximum of 51 °C (124 °F). The minimum temperature reading is suspected to be a Celsius reading recorded as Fahrenheit. Plots of the individual thermocouple readings can be found in the HTCE supporting document for the BX Tank Farm (Brevick et al. 1994). The graph of the weekly high temperature is provided in Figure 2-5.

2.4.4 Tank 241-BX-104 Photographs

The 1989 montage of the tank 241-BX-104 interior indicates a pockmarked black sludge surface with small pools of liquid at the bases of the turbine pump and Food Instrument Corporation gauge. At the time the photographs were taken, the tank contained approximately 375 kL (99 kgal) of waste, which equals approximately 799 mm (31.5 in.) of depth. The montage should accurately represent the current appearance of the waste.

Figure 2-3. Tank Layer Model for Tank 241-BX-104.

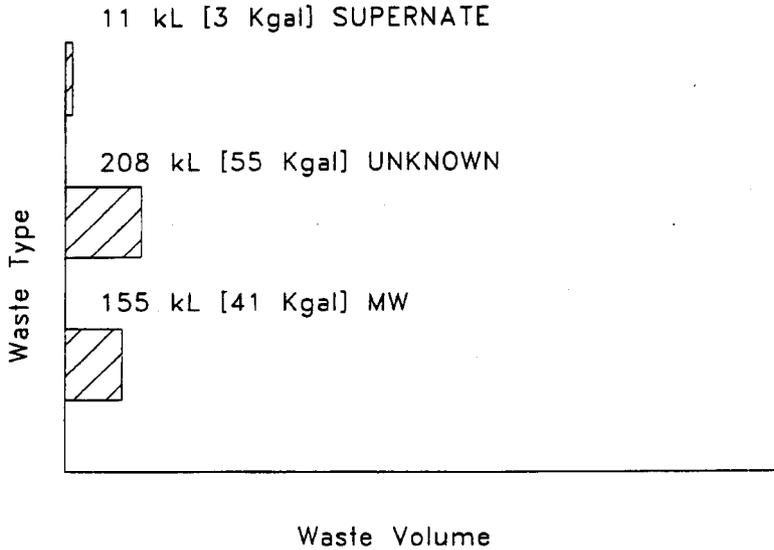


Figure 2-4. Tank 241-BX-104 Level History.

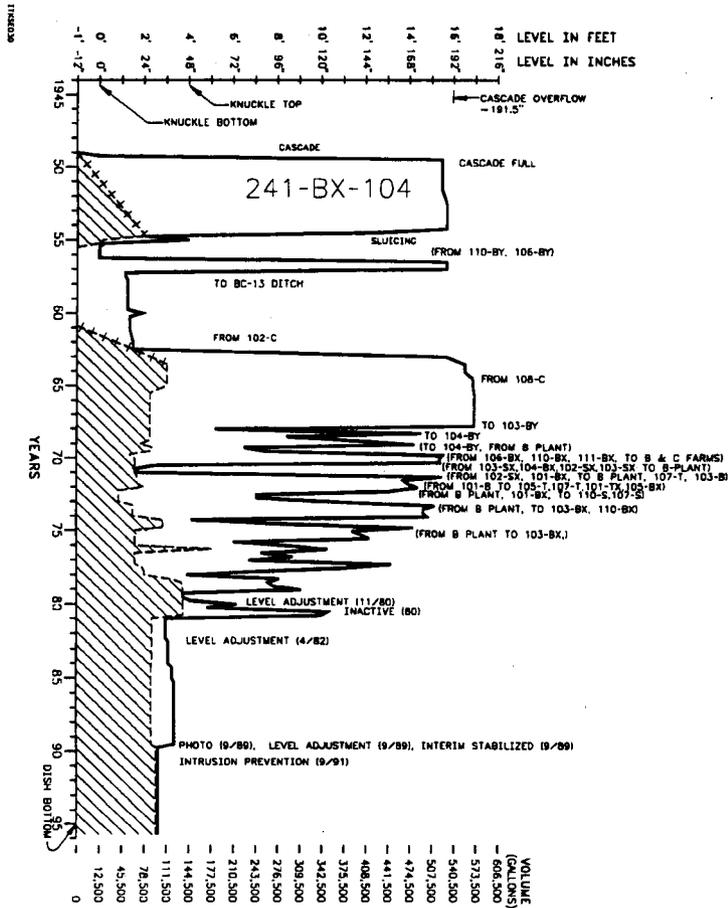
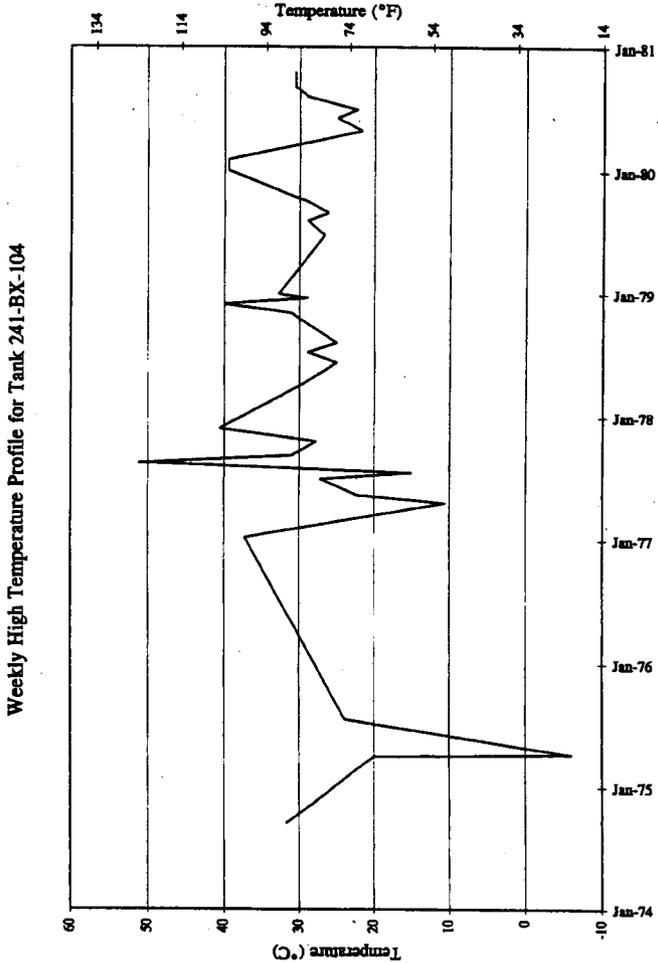


Figure 2-5. Tank 241-BX-104 Peak Temperature Plot.



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3.0 TANK SAMPLING OVERVIEW

This section primarily describes the January 1996 sampling and analysis event for tank 241-BX-104. The core sampling was performed to satisfy the requirements of the Safety Screening (Dukelow et al. 1995) and Organic Complexant Safety (Turner et al. 1995) DQOs. Two push-mode cores were sampled and analyzed in accordance with the sampling and analysis plan (SAP) (Gretsinger 1996). Prior to and during the sampling event, a tank headspace vapor flammability test was performed in accordance with the Safety Screening DQO. The results of these analyses have been reported in *Final Report for Tank 241-BX-104, Push-Mode Cores 126 and 127* (Hu 1996). Further discussion of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (De Lorenzo et al. 1994).

Table 3-1 summarizes the applicable DQOs and their respective sampling and analysis requirements for the January 1996 core sampling event.

Several historical sampling events will be briefly discussed in Section 3.5. They are the 1994 headspace vapor sampling event, the 1986 core sampling event, and seven supernatant sample events that occurred between 1974 and 1980.

Table 3-1. Integrated Data Quality Objective Requirements for Tank 241-BX-104.¹

| Sampling Event | Applicable DQOs | Sampling Requirements | Analytical Requirements |
|--|---|---|--|
| Push-mode core sampling (January 1996) | <ul style="list-style-type: none"> ▶ Safety Screening ▶ Organic Complexant Safety | <ul style="list-style-type: none"> ▶ Core samples from two risers separated radially to the maximum extent possible. ▶ Flammability samples taken from tank dome. | <ul style="list-style-type: none"> ▶ Energetics ▶ Moisture content ▶ Total alpha ▶ Bulk density ▶ Bromide ▶ Selected metals ▶ TOC ▶ Headspace gas flammability ▶ Visual check for presence of organic layer³ ▶ Opportunistic analyses² |

Notes:

¹Gretsinger (1996)

²Kristofzski (1995)

³Drainable liquid samples only.

3.1 DESCRIPTION OF THE 1996 PUSH-MODE CORE SAMPLING EVENT

Based on the waste type, waste volume, historical sample results and in-tank photos, the push-mode core sampling method was chosen to obtain a vertical profile of the tank waste. Two push-mode core samples of two segments each were collected from tank 241-BX-104 on January 5 and 6, 1996. Cores 126 and 127 were taken from risers 7 and 1, respectively. A hydrostatic head fluid (HHF) field blank sample containing lithium bromide as a tracer was taken on January 11, 1996 and delivered to the laboratory by January 12, 1996. All samples were received, extruded, and analyzed at the Pacific Northwest National Laboratory (PNNL).

Core 127 segment 2 was contaminated by HHF. The HHF intrusion analysis for this segment indicated that 52 percent of the water present in the solid portion and 63 percent of the water in the liquid portion was from HHF. Because this intrusion was greater than 50 percent, the sample results were not included in the tank inventory calculation (Hu 1996). In addition to the contamination of the samples, some confusion arose concerning a mishandled HHF field blank. Eventually, an HHF blank value was derived from the average of HHF blank values from eight other tanks (Hu 1996).

3.2 SAMPLE HANDLING

The sampling information, subsampling scheme, and sample descriptions for cores 126 and 127 are presented in Table 3-2. Upon delivery to the PNNL 325 Analytical Chemistry Laboratory, cores 126 and 127 were extruded, photographed, and subsampled as prescribed in the SAP (Gretsinger 1996).

The expected sample length for core samples is normally 48 cm (19 in.) except for the first segment, which can be any length up to 48 cm, depending on the height of the waste at the sampling point. Approximately 27 cm (10 in.) of sample was extracted from segment 1 of cores 126 and 127. The sampling recovery was calculated based on the field waste level measurement, the sampler stroke adjustment information, and the bulk density results of solids. The amount of sample recovered differed between the segments. Based on total recovery, the material from segment 2 of core 126 and segment 1 of core 127 were divided into half segments labeled as upper and lower halves. The material that was collected first came from the top half of the sampler and was designated the upper half subsegment. The recoveries for segment 1 of core 126 and segment 2 of core 127 were small enough that they were to be analyzed as whole segments. Not enough drainable liquid was collected from any of the segments to warrant their being divided in half.

3.3 SAMPLE ANALYSIS

The analyses were performed at the half segment level (if available) on core samples 126 and 127; no composite samples were analyzed. Initially, the analyses were limited to those needed to satisfy the primary safety screening and organic complexant safety program requirements. These analyses include DSC, TGA, total alpha activity through alpha proportional counting, bulk density measurement by centrifugation, and a visual examination of all liquid samples for the presence of an organic layer. The Safety Screening DQO also requires a determination of the flammability of the tank headspace gases. To satisfy this requirement, vapor samples were taken prior to and during core sampling, and the flammability was measured as a percentage of the lower flammability limit (LFL) using a combustible gas meter. The Organic Complexant Safety DQO also required analyses for fuel content and weight percent (wt%) water, as well as for total organic carbon (TOC) to evaluate its contribution to the total fuel content. Ion chromatograph (IC) for bromide and ICP for lithium were performed to analyze the LiBr for monitoring HHH contamination. In addition, GEA was performed for selected subsamples, along with ICP data to evaluate the homogenization effect in the sample preparation. Drainable liquid subsamples were analyzed directly or after dilution in water or acid. Depending on the analysis, sludge subsamples were analyzed directly; or after a fusion or water digestion. Because no results exceeded any of the DQO decision limits, no secondary analyses were required. However, in the process of meeting these requirements, opportunistic analytical results for metals, anions, and carbon were obtained to provide optimal information (Kristofzski 1995).

A list of all samples by Westinghouse Hanford Company sample identification number, PNNL identification number, core, segment portion, and their associated analyses is shown in Table 3-3. Analytical samples were prepared from homogenized subsegment (or whole segment, as applicable) material. The solid, drainable liquid, field blank, and HHH samples were transferred and processed through the Shielded Analytical Laboratory Hot Cell Facility for radiation protection. Table 3-4 summarizes the instruments, analytical sample preparation methods, and the analytical procedures for the requested suite of analyses. Subsegments 2B for core 126 and 2A for core 127 were selected for evaluating the effectiveness of the homogenization operation. For these half-segments, material was subsampled from the top and bottom of the homogenized sample. Each subsample was prepared in duplicate by KOH-KNO₃ fusion and distributed for ICP and GEA analysis.

Quality control (QC) checks included, when appropriate, laboratory control standards, matrix spikes, duplicate analyses, and method blanks. Results of the QC checks and their implications on data quality are presented in Section 5.1.2.

Table 3-2. Subsampling Scheme and Sample Description.¹ (2 sheets)

| Sample | Date Sampled Received Extruded | Dose Rate Through Drill String (mR/hr) | Sample Recovery | Sample Description |
|------------------------------------|--------------------------------------|--|--|---|
| Riser 7, Core 126, Segment 1 | 1/5/96 1/10/96 1/25/96 | 1,300 | Whole solids: 206.2 g Drainable liquid: 18.9 mL Liner liquid: 28 mL Recovery: 87% | Expected 27 cm of waste. No crust observed. Recovered roughly 12 cm of solid material, dark brown with a patch of white-gray slurry. |
| Riser 7 Core 126 Segment 2 | 1/5/96 1/10/96 1/26/96 | 800 | Upper half solids: 201.7 g Lower half solids: 205.7 g Drainable liquid: 20.0 mL Liner liquid: 0 mL Recovery: 79% | Expected 48 cm of waste. Recovered 38 cm solid material. First half of solids was light gray-brown and held shape. Second half of solids was smeared layers of gray and brown. The solids were wet but crumbly. |
| Riser 1 Core 127 Segment 1 | 1/6/96 1/10/96 1/27/96 | 800 | Upper half solids: 125.9 g Lower half solids: 98.9 g Drainable liquid: 9.0 mL Liner liquid: 19 mL Recovery: 99% | Expected 27 cm of waste. Recovered 34 cm of waste. First 23 cm of solids was thick, steel-gray sludge that flowed slightly upon extrusion. The remaining material was black and flowed. Drainable liquid was black-gray in color. |

Table 3-2. Subsampling Scheme and Sample Description.¹ (2 sheets)

| Sample | Date Sampled Received Extruded | Dose Rate Through Drill String (mR/hr) | Sample Recovery | Sample Description |
|------------------------------------|--------------------------------------|--|---|--|
| Riser 1 Core 127 Segment 2 | 1/6/96 1/10/96 1/29/96 | 450 | Whole solids: 153.5 g Drainable liquid: 65.0 mL Liner liquid: 0 mL Recovery: 50% | Expected 48 cm of waste material. Recovered solid material was wet and crumbly black-brown. Drainable liquid was milky yellow in color. |
| Riser 7 Core 126 Field blank | 1/5/96 1/10/96 1/27/96 | < 0.5 | Field blank: 236.4 mL Liner liquid: 0 mL | The field blank was a clear, colorless liquid. |
| Hydrostatic head fluid blank | 1/11/96 1/12/96 N/A | < 0.5 | N/A | N/A |

Note:

¹Hu (1996)

Table 3-3. Sampling Analysis Summary.¹ (2 sheets)

| WHC Sample Identification Number | PNNL Identification Number | Samples | Sample Analyses |
|----------------------------------|----------------------------|--|--|
| 96-021 | 96-02979 | Core 126, segment 1A ² , whole segment | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |
| | 96-02989 | Core 126, segment 1, drainable liquid | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |
| 96-022 | 96-02981 | Core 126, segment 2A, upper half solids | DSC, TGA, bulk density, TOC, ICP, IC |
| | 96-02982 ⁴ | Core 126, segment 2B ³ , lower half solids | DSC, TGA, bulk density, total alpha, GEA, TOC, IC, ICP |
| | 96-02980 ⁴ | Core 126, segment 2BH ⁴ , lower half solids | GEA, ICP |
| | 96-02990 | Core 126, segment 2, drainable liquid | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |
| 96-023 | 96-02983 | Core 127, segment 1A, upper half | DSC, TGA, bulk density, TOC, IC, ICP |
| | 96-02984 | Core 127, segment 1B, lower half solids | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |
| 96-024 | 96-02985 ⁴ | Core 127, segment 2A, whole segment | DSC, TGA, bulk density, total alpha, GEA, TOC, IC, ICP |
| | 96-02986 ⁴ | Core 127, segment 2AH, whole segment | GEA, ICP |
| | 96-02992 | Core 127, segment 2, drainable liquid | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |

Table 3-3. Sampling Analysis Summary.¹ (2 sheets)

| WHC Sample Identification Number | PNNL Identification Number | Samples | Sample Analyses |
|----------------------------------|----------------------------|----------------|--|
| Field blank | 96-02987 | N/A | DSC, TGA, bulk density, total alpha, TOC, IC, ICP |
| Hydrostatic head fluid blank | 96-02988 | N/A | IC, ICP |
| Vapor tests | N/A | Tank headspace | Combustible gas meter readings for: flammable gas concentration, oxygen, total organic vapors, ammonia |

Notes:

¹Hu (1996)²A = upper segment half or whole segment³B = lower half segment⁴H = homogenization sample

Table 3-4. Analytical Methods and Procedures.¹

| Analysis | Instrument/Method | Preparation Procedure ² | Analytical Procedure ² |
|---|--|--|--|
| Differential scanning calorimetry | Seiko™ 5200 | Direct | PNL-ALO-508, Rev. 0 |
| Thermogravimetric analysis | Seiko™ 5200 | Direct | PNL-ALO-508, Rev. 0 |
| Bulk density | Centrifuge cones and electronic balance | Direct | PNL-ALO-501, Rev. 0 |
| Total alpha activity | Ludlum™ zinc sulfide scintillation counter | PNL-ALO-115, Rev. 1 PNL-ALO-106, Rev. 1 | PNL-ALO-420, Rev. 1 PNL-ALO-421, Rev. 1 |
| Gamma energy analysis | Germanium gamma detectors | PNL-ALO-115, Rev. 1 | PNL-ALO-450, Rev. 1 |
| Inductively coupled plasma spectrometry | Jarrell-Ash™ ICP 800A system | PNL-ALO-115, Rev. 1 | PNL-ALO-211, Rev. 0 |
| Ion chromatography | Dionex™ 4500i system | PNL-ALO-103 | PNL-ALO-212, Rev. 1 |
| Total carbon (TC, TOC, TIC) | Hot persulfate digestion method and coulometry | PNL-ALO-381, Rev. 1 | PNL-ALO-381, Rev. 1 |
| Flammable gas | Combustible gas meter readings | N/A | WHC-IP-0030 IH 1.4 and IH 2.1 |

Notes:

Seiko 5200™ is a registered trademark of Seiko Instruments, Torrance, California.

Ludlum™ is a registered trademark of Ludlum Measurements, Inc., Sweetwater, Texas.

Jarrell-Ash ICP 800A System™ is a registered trademark of Jarrell-Ash, Inc., Menlo Park, California.

Dionex 4500i™ is a registered trademark of Dionex Corporation, Sunnyvale, California.

TC = total carbon

TOC = total organic carbon

TIC = total inorganic carbon

¹Hu (1996)

²PNL procedures are internal procedures of Pacific Northwest National Laboratory, Richland, Washington. WHC procedures are internal procedures of Westinghouse Hanford Company, Richland, Washington.

3.4 DESCRIPTION OF TANK HEADSPACE VAPOR FLAMMABILITY TEST

Tank 241-BX-104's headspace vapor flammability was tested on January 5, 1996 to satisfy the tank headspace flammability screening requirement of the Safety Screening DQO. Tank headspace vapor flammability was determined in the field by means of a combustible gas meter. The tank headspace vapor sample was drawn from a point 90 cm (3 ft) below risers 1 and 7. The combustible gas meter indicated that the tank headspace was 0 percent of the LFL; this result satisfies the Safety Screening DQO requirement that the tank headspace be \leq 25 percent of the LFL. Flammable and noxious gases are discussed more fully in Section 4.1.3.

3.5 PREVIOUS SAMPLING EVENTS

This section presents a discussion of the historical sampling and analysis events for tank 241-BX-104. There are nine historical sample events—one sampling each of headspace vapor and tank solids and seven of the supernatants. A discussion of these sampling events follows.

3.5.1 Description of the Vapor Sampling Event (1994)

The tank headspace was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994). This DQO directed the collection and analysis of headspace vapor samples to help determine the potential risks of fugitive emissions to tank farm workers. The results have been reported in *Tank 241-BX-104 Headspace Gas and Vapor Characterization Results for Samples Collected in December 1994* (Huckaby and Bratzel 1995). The summarized results are found in Section 4.2.

3.5.2 Sample Handling and Analysis (1986)

Two core samples of the sludge, obtained through risers 1 and 8, were taken in February 1986. Further detail regarding the sampling event can be found in Weiss and Schull (1988). One hundred percent of the expected sample was recovered during the sampling event, except for segment 2 of the first core, which had a recovery of 82 percent. The analytical results from this sampling event have also been included in Appendix C.

After the samples were received by the Westinghouse Hanford Company 222-S Laboratory, they were centrifuged and separated for analysis, and composites of each core were made. The solids were water leached, acid leached, and treated for dissolution in a HNO_3 -HF-HCL solution (fusion). The HNO_3 -HF-HCL and acid leach fractions were combined for analysis. Consequently, only two analytical values were generated for each core, one from the water

digestion and one from the fusion/acid digestion combination. The two values were summed, as directed by Weiss and Schull (1988), to calculate a core mean, and an overall mean was derived by averaging the two core means.

An extensive set of analyses was performed on the core composites. Twenty-three metals, nine radionuclides, nitrate, TOC, pH, density, and particle size were measured on the samples. A viscosity test could not be performed because the waste was too solid (Weiss and Schull 1988). The data from these analyses have been compiled in Table C-2 in Appendix C.

3.5.3 Description of the Supernatant Sampling Events

Seven supernatant sample events were performed between 1974 and 1980. All of the samples were taken to determine if the tank's contents were suitable for concentration in either the 242-S or the 242-A Evaporators. No mode of sampling was given for the sampling events, although it is likely that the sampling method was bottle-on-a-string. The sample handling was similar for each sampling event. After retrieval, the samples were split into two portions. A batch boildown was performed on one portion, while the second was subjected to a chemical analysis. The boildown portion was placed in a laboratory vacuum to simulate the evaporators' operations.

The chemical analytical results from all seven sampling events have been included in Appendix C. However, it should be noted that the results from these sampling and analysis events are probably not representative of the current tank contents. The tank was quite active until November 1980. The date of the last reported supernatant sampling event was August 14, 1980; however, the actual date is unknown. The tank received 5,910 kL (1,560 kgal) of waste in the third quarter, most of which was also transferred out during the third quarter for concentration in the 242-A Evaporator. The sampling event discussed in the August report may have been for this evaporator run, or may have been performed earlier. Regardless, another 837 kL (221 kgal) were received in the fourth quarter of 1980, definitely after the August sampling event.

4.0 ANALYTICAL RESULTS

Section 4.0 presents a summary of the analytical results associated with the January 1996 sampling of tank 241-BX-104. The sampling and analysis parameters governing this event were integrated by and described in the SAP (Gretsinger 1996). Extrusion and analysis of the core samples were performed at the PNNL 325 Analytical Chemical Laboratory.

Data locations for this tank characterization report are displayed in Table 4-1. As noted in Table 4-1, the complete analytical data set can be found in Appendix A. Only analyte overall means are reported in Section 4.0. Appendix B contains the data for lithium and bromide, the analytes evaluated to gauge the amount of contamination by the HHF.

Table 4-1. Analytical Data Presentation Tables.

| Data Type | Tabulated Location |
|---|--------------------|
| Chemical data summary | Table 4-2 |
| Headspace flammability screening results | Table 4-3 |
| 1994 vapor sampling results | Table 4-4 |
| Comprehensive analytical data | Appendix A |
| Hydrostatic head fluid contamination check data | Appendix B |
| 1986 historical sampling data | Appendix C |

4.1 1996 CORE SAMPLING DATA PRESENTATION

This section summarizes results from the January 1996 push-mode core sampling of tank 241-BX-104. The data were reported in *Final Report for Tank 241-BX-104, Push-Mode Cores 126 and 127* (Hu 1996).

4.1.1 Chemical Data Summary

Table 4-2 presents the mean concentration estimates and inventories for the sludge and drainable liquid results separately. Data from the two push-mode core samples were combined to derive overall means for all analytes except DSC, which does not require calculation of a mean. All information contained in Table 4-2 was taken from the Appendix A tables. The table is divided into two sections. The first section presents the data from the analysis of the sludge samples, and the second section presents the data from the analysis of the drainable liquid samples. The first column of Table 4-2 contains the name of the analyte. The second and fifth columns of each section contain the overall means. The

third and sixth columns of each section display the relative standard deviation (RSD) of the mean, defined as the standard deviation of the mean divided by the mean, multiplied by 100. The RSDs were determined by using standard analysis of variance (ANOVA) statistical techniques, and were computed only for those analytes with 50 percent or more of the individual sample and duplicate results either estimated and/or above the detection limit.

In order to make a best estimate of projected inventories, the sludge and drainable liquid volumes were obtained using two methods. One method uses the Hanlon 1996 report, which lists 250 kL (66 kgal) and 125 kL (33 kgal) of sludge and drainable liquid, respectively. The drainable liquid estimate is based on the surveillance information, which adds the 11 kL (3 kgal) of supernatant to the 114 kL (30 kgal) of drainable liquid. The drainable interstitial liquid was calculated by using an estimated 0.45 sludge porosity. The other method used the current core sampling extrusion results to determine the volume ratio of drainable liquid and sludge obtained from all the segments (except core 127 segment 2, which was HHF contaminated). The sludge and drainable liquid volumes are approximately 341 kL (90 kgal) and 34 kL (9 kgal), respectively. The projected inventories listed in the fourth and seventh columns of Table 4-2 were obtained by using the sludge and drainable liquid volumes determined by the core sampling information; in the calculation the mass bases were $5.887\text{E}+08$ g and $34.4\text{E}+06$ mL for sludge and drainable liquid, respectively.

The overall weighted mean for the sludge samples was calculated by first averaging the individual primary and duplicate results for each sample. The sample means within a given subsegment (upper half, lower half, or whole) were then averaged to obtain a subsegment mean, the subsegment means within a given segment were then averaged to obtain a segment mean; the segment means within a given core were then averaged to obtain a core mean. The exception was segment 2 of core 127, which was contaminated with hydrostatic head fluid to the point of making the analytical results unusable. The analytical results from segment 2 of core 127 are included in Appendix A for informational purposes only. Finally, the two core means were averaged to derive the overall tank means. Not all of these steps are necessary for each analyte or for each subsegment, but the procedure to be followed is the same.

The overall tank means for the drainable liquid samples were based on the results from core 126 only. The overall means for each analyte were calculated by simply averaging the sample means from the two core 126 segments.

The overall mean and projected inventories listed in Table 4-2 were either detected, estimated (\approx), or nondetected ($<$) values. For example, when 50 percent or more of the primary and duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when greater than half of the individual primary and duplicate measurements had nondetected results, the overall mean was reported as a nondetected value. A full explanation as to how these designations were applied is given in the introduction to Appendix A.

Table 4-2. Chemical Data Summary for Tank 241-BX-104.¹ (3 sheets)

| Analyte | Sludge ² | | | Drainable Liquid ² | | |
|------------|---------------------|------------|---------------------|-------------------------------|------------|---------------------|
| | Overall Mean | RSD (Mean) | Projected Inventory | Overall Mean | RSD (Mean) | Projected Inventory |
| METALS | µg/g | % | kg | µg/mL | % | kg |
| Aluminum | 1.15E+05 | 57.1 | 67,700 | 2,840 | 1.1 | 98.0 |
| Arsenic | < 546 | N/A | < 322 | ≈ 8.65 | 10.1 | ≈ 0.298 |
| Barium | ≈ 38.9 | 27.1 | ≈ 22.9 | ≈ 0.650 | 12.0 | ≈ 0.0224 |
| Beryllium | < 13.4 | N/A | < 7.89 | < 0.488 | N/A | < 0.0168 |
| Bismuth | ≈ 551 | 25.0 | ≈ 325 | ≈ 6.90 | 5.8 | ≈ 0.238 |
| Boron | ≈ 219 | 15.7 | ≈ 129 | 28.4 | 11.0 | 0.980 |
| Cadmium | < 150 | N/A | < 88.4 | ≈ 1.70 | 19.4 | ≈ 0.0587 |
| Calcium | ≈ 1,900 | 19.7 | ≈ 1,120 | ≈ 19.1 | 33.9 | ≈ 0.659 |
| Cerium | < 322 | N/A | < 190 | < 3.25 | N/A | < 0.112 |
| Chromium | 6,330 | 63.6 | 3,730 | 2,970 | 12.1 | 102 |
| Cobalt | < 134 | N/A | < 78.9 | < 1.63 | N/A | < 0.0562 |
| Copper | < 167 | N/A | < 98.4 | ≈ 2.52 | 17.6 | ≈ 0.0869 |
| Dysprosium | < 134 | N/A | < 78.9 | ≈ 1.63 | N/A | < 0.0562 |
| Europium | < 268 | N/A | < 158 | < 3.25 | N/A | < 0.112 |
| Iron | 6,400 | 57.2 | 3,770 | ≈ 2.05 | 2.4 | ≈ 0.0707 |
| Lanthanum | < 138 | N/A | < 81.3 | < 1.63 | N/A | < 0.0562 |
| Lead | ≈ 946 | 10.5 | ≈ 557 | < 16.3 | N/A | < 0.562 |
| Magnesium | < 270 | N/A | < 159 | < 3.25 | N/A | < 0.112 |
| Manganese | ≈ 1,540 | 66.8 | ≈ 907 | < 1.63 | N/A | < 0.0562 |
| Molybdenum | < 80.5 | N/A | < 47.4 | 32.9 | 4.3 | 1.14 |
| Neodymium | < 300 | N/A | < 177 | < 3.25 | N/A | < 0.112 |
| Nickel | NR | NR | NR | ≈ 8.90 | 54.9 | ≈ 0.307 |
| Palladium | < 805 | N/A | < 474 | < 16.3 | N/A | < 0.562 |
| Phosphorus | ≈ 2,340 | 34.9 | ≈ 1,380 | 1,780 | 10.8 | 61.4 |
| Potassium | NR | NR | NR | 2,010 | 3.8 | 69.3 |
| Rhodium | < 805 | N/A | < 474 | ≈ 6.85 | 9.9 | ≈ 0.236 |
| Ruthenium | < 268 | N/A | < 158 | ≈ 7.70 | 5.2 | ≈ 0.266 |
| Selenium | ≈ 1,040 | 22.1 | ≈ 613 | < 16.3 | N/A | < 0.562 |
| Silicon | ≈ 1,880 | 15.2 | ≈ 1,110 | ≈ 82.4 | 35.6 | ≈ 2.84 |

Table 4-2. Chemical Data Summary for Tank 241-BX-104.¹ (3 sheets)

| Analyte | Sludge ² | | | Drainable Liquid ² | | |
|----------------------|---------------------|------------|---------------------|-------------------------------|------------|---------------------|
| | Overall Mean | RSD (Mean) | Projected Inventory | Overall Mean | RSD (Mean) | Projected Inventory |
| METALS | $\mu\text{g/g}$ | % | kg | $\mu\text{g/mL}$ | % | kg |
| Silver | < 56.5 | N/A | < 33.3 | < 0.488 | N/A | < 0.0168 |
| Sodium | 72,700 | 30.6 | 42,800 | 1.40E+05 | 0.8 | 4,830 |
| Strontium | \approx 51.1 | 17.3 | \approx 30.1 | < 0.488 | N/A | < 0.0168 |
| Tellurium | < 1,340 | N/A | < 789 | < 16.3 | N/A | < 0.562 |
| Thallium | < 1,340 | N/A | < 789 | < 16.3 | N/A | < 0.562 |
| Tin | < 2,680 | N/A | < 1,580 | < 32.5 | N/A | < 1.12 |
| Titanium | < 67.3 | N/A | < 39.6 | < 0.813 | N/A | < 0.0280 |
| Tungsten | < 1,340 | N/A | < 789 | \approx 40.4 | 4.0 | \approx 1.39 |
| Uranium | 38,400 | 42.5 | 22,600 | < 65.0 | N/A | < 2.24 |
| Vanadium | \approx 45.2 | 7.3 | \approx 26.6 | < 2.48 | N/A | < 0.0856 |
| Yttrium | < 36.5 | N/A | < 21.5 | < 0.325 | N/A | < 0.0112 |
| Zinc | \approx 220 | 14.7 | \approx 130 | \approx 1.4 | 14.8 | \approx 0.0483 |
| Zirconium | < 646 | N/A | < 380 | < 1.63 | N/A | < 0.0562 |
| ANIONS | $\mu\text{g/g}$ | % | kg | $\mu\text{g/mL}$ | % | kg |
| Chloride | 1,040 | 17.7 | 613 | 2,800 | 3.6 | 96.6 |
| Fluoride | < 882 | N/A | < 519 | 300 | 0.0 | 10.4 |
| Nitrate | 47,800 | 22.4 | 28,200 | 1.35E+05 | 12.3 | 4,660 |
| Nitrite | 24,200 | 28.5 | 14,300 | 63,800 | 5.9 | 2,200 |
| Phosphate | 8,490 | 54.9 | 5,000 | 4,780 | 3.7 | 165 |
| Sulfate | 1,750 | 21.2 | 1,030 | 3,930 | 4.5 | 136 |
| RADIONUCLIDES | $\mu\text{Ci/g}$ | % | Ci | $\mu\text{Ci/g}$ | % | Ci |
| Total alpha | 1.28 | 71.8 | 754 | 2.63E-04 | 58.2 | 0.0117 |
| ¹³⁷ Cs | 73.1 | 3.7 | 43,100 | N/A | N/A | N/A |

Table 4-2. Chemical Data Summary for Tank 241-BX-104.¹ (3 sheets)

| Analyte | Sludge ² | | | Drainable Liquid ² | | |
|------------------------|---------------------|------------|---------------------|-------------------------------|------------|---------------------|
| | Overall Mean | RSD (Mean) | Projected Inventory | Overall Mean | RSD (Mean) | Projected Inventory |
| CARBON | $\mu\text{g C/g}$ | % | kg C | $\mu\text{g C/mL}$ | % | kg C |
| Total carbon | 10,000 | 33.2 | 5,890 | 12,100 | 17.8 | 417 |
| Total inorganic carbon | 4,830 | 35.4 | 2,840 | 8,950 | 12.9 | 309 |
| Total organic carbon | 5,210 | 42.1 | 3,070 | 3,190 | 31.3 | 110 |
| PHYSICAL PROPERTIES | | | | | | |
| Water | 29.5 wt % | 51.7 | 174,000 kg | 59.1 wt % | 1.1 | 26,300 kg |
| Density | 1.73 g/mL | 11.8 | N/A | 1.29 g/mL | 0.4 | N/A |

Notes:

N/A = not applicable.
 NR = not reported.

¹Hu (1996)

²The mass basis used in the inventory calculation were $5.89\text{E}+08$ g and $34.4\text{E}+06$ mL for the sludge and drainable liquid, respectively.

4.1.2 Physical Data Summary

Thermal analyses and density were performed on the tank 241-BX-104 core samples to satisfy the requirements of the Safety Screening DQO (Dukelow et al. 1995). The Organic Complexant Safety DQO (Turner et al. 1995) also required thermal analyses. Both DQOs required a visual check for the presence of an organic layer.

4.1.2.1 Thermogravimetric Analysis. During a TGA, the mass of a sample is measured while its temperature is increased at a constant rate. Nitrogen is passed over the sample during the heating to remove any released gases. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 °C) is due to water evaporation. Thermogravimetric analysis was performed on homogenized solid samples and directly on drainable liquids.

The TGA results for tank 241-BX-104 are presented in Appendix A in Table A-51. All sludge samples exhibited a large weight loss between the ambient temperature and 180 °C, which is associated with the first endothermic transition. Again, this weight loss was attributed to the evaporation of water. The overall mean percent water for the sludge was 29.5 wt%; that for the drainable liquids was 59.1 wt%.

4.1.2.2 Differential Scanning Calorimetry. During a DSC, heat absorbed or emitted by a substance is measured while the substance is exposed to a linear increase in temperature. While the substance is being heated, nitrogen is passed over it to remove any gases being released. The onset temperature for an endothermic (characterized by or causing the absorption of heat) or an exothermic (characterized by or causing the release of heat) event is determined graphically.

The DSC results (wet basis) are presented in Appendix A in Table A-52. The peak temperature and maximum enthalpy changes are given for each sample. The first transition represents the endothermic reaction associated with the evaporation of free and interstitial water. The second transition probably represents the energy (heat) required to remove bound water from hydrated compounds such as aluminum hydroxide or to melt salts such as sodium nitrate. The third transition is generally exothermic and is probably caused by the fuel components of the sample reacting with the nitrate salts. None of the samples exceeded the Safety Screening and Organic Complexant Safety DQO decision threshold of -480 J/g. The highest individual sample result was -74.0 J/g (dry basis), and the highest upper limit of a one-sided 95 percent confidence interval was -174 J/g (dry basis).

4.1.2.3 Density. Density measurements of the half-segments and drainable liquids were performed in duplicate by measuring the volume and weight of each phase (solid and liquid) of a centrifuged sample. Density ranged from a high of 2.02 g/mL for the sludge from the lower half of core 126, segment 2 to a low of 1.27 g/mL for the drainable liquid from segments 1 and 2 of core 126. The results are presented in Table A-53. The average density for the sludge was 1.73 g/mL, and that for the drainable liquids was 1.29 g/mL.

4.1.2.4 Visual Check for an Organic Layer. A visual check for an organic layer was made in accordance with the Safety Screening and Organic Complexant Safety DQOs. The presence of an organic layer was not noted in the sample description.

4.1.3 Headspace Flammability Screening Results

As required by the Safety Screening DQO (Dukelow et al. 1995) and requested in the SAP (Gretsinger 1996), the tank headspace was sampled and analyzed by combustible gas meter for the presence of flammable gases prior to core sampling. Risers 1 and 7 were used for flammable gas sampling, at a depth of 90 cm (3 ft) below the riser. The reported LFL of 0 percent was well below the Safety Screening DQO limit. In addition, the concentration of oxygen gas, ammonia gas, and total organic carbon vapors were determined by combustible

gas meter, color matrix ammonia tube, and photoionization detector, respectively. Oxygen and total organic vapors were within limits; however, ammonia was above the threshold for breathing set by the National Institute of Safety and Health (Hu 1996). The results of the flammable gas monitoring are presented in Table 4-3.

Table 4-3. Headspace Flammability Screening for Tank 241-BX-104.¹

| Vapor Characteristic Measured | Results | |
|--|---------------------------------|---------------------------------|
| | Riser 1, 90 cm Below Riser 1 | Riser 7, 90 cm Below Riser 7 |
| Flammability vapor concentration as percent of the LFL | 0% | 0% |
| Volume percent oxygen gas | 20.6% | 20.9% |
| Concentration of ammonia gas | 50 ppm | 200 ppm |
| Concentration of total organic carbon vapor | 5 ppm | 8 ppm |

Note:

¹Hu (1996)

4.1.4 Hydrostatic Head Fluid Contamination Check

Analysis by ICP and IC revealed that the concentrations of lithium and bromide, respectively, were higher in the drainable liquid and sludge samples from core 127, segment 2 (sample WHC-96-024) than the concentrations in the HHF blank. The drainable liquid sample also contained higher concentrations of aluminum, chromium, and sodium than would be expected in pure HHF. Upon further investigation it was found that the wrong HHF blank sample had been delivered to the laboratory. The average lithium bromide concentration in the HHF blanks from eight other tanks was used to evaluate the intrusion of HHF into the samples.

The intrusion evaluation showed that the sludge and drainable liquid samples were contaminated with HHF (Hu 1996). The analysis indicated that 52 percent of the water present in the sludge sample and 63 percent of the water in the drainable liquid sample was from HHF. The results of the lithium and bromide analyses are reported in Appendix B. Because the intrusion was greater than 50 percent, the analytical results were not correct due to the complicated dilution/dissolving process in the contamination sample, and the uncertainty of the moisture calculation.

The analytical results from this segment will not be factored into the overall mean calculation or used for further data comparison. However, the data will be used to evaluate against the safety program criteria. The DSC exotherm result is measured in dry weight basis and will not be impacted at all. In addition, the TOC data were taken on a wet weight basis, and converted to dry weight basis using the TGA data. The calculated TOC (dry weight basis) for the HHF-contaminated sample will give the upper limit of the true value. Therefore, the HHF-contaminated sample results are still valid for a conservative comparison against the 3 wt% TOC criteria. For the total alpha, the observed values for this segment are two orders of magnitude smaller than the notification limit, and have no impact on safety concerns.

4.1.5 Opportunistic Analyses of Metals, Anions, and Carbon

The SAP for tank 241-BX-104 requires the analysis of lithium and bromide whenever HHF is used in the sampling process, as discussed in Section 4.1.4. Along with lithium, other selected metals were measured, including aluminum, bismuth, calcium, iron, phosphorus, sodium, chromium, manganese, nickel, silicon, and uranium. These metals were all measured as primary analytes, but are not discussed in Section 5.5 because they are not associated with safety. Several other anions were also obtained opportunistically during the analysis for bromide, and total inorganic carbon (TIC) and total carbon (TC) were obtained during analysis for TOC. Their concentrations, means, and projected inventories are presented in Appendix A.

4.2 DATA SUMMARY OF 1994 VAPOR SAMPLING

Tank 241-BX-104's headspace was sampled on December 30, 1994 by WHC Sampling and Mobile Laboratories. Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). Results from this sampling were reported in Huckaby and Bratzel (1995).

Inorganic gases and vapors were sampled by sorbent trap and SUMMA² canister tank, and analyzed by PNNL. Organic vapors were sampled using SUMMATM canisters analyzed by PNNL (Pool et al. 1995), and triple sorbent traps analyzed by ORNL (Jenkins et al. 1995). A summary of the results of inorganic and organic samples collected from the headspace of tank 241-BX-104 are given in Table 4-4.

²SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

Table 4-4. Summary Results of Inorganic and Organic Samples Collected from the Tank 241-BX-104 Headspace in December 1994.¹

| Species | CAS Number | Average | STD | RPD |
|------------------------------|------------|---------|--------|-----|
| INORGANICS | | ppmv | ppmv | % |
| Ammonia | 7664-41-7 | 235 | 3 | 1 |
| Carbon Dioxide | 124-38-9 | 74 | 27 | 36 |
| Carbon Monoxide | 630-08-0 | < 12 | -- | -- |
| Hydrogen | 1333-74-0 | < 94 | -- | -- |
| Nitric Oxide | 10102-43-9 | 0.3 | 0.02 | 7 |
| Nitrogen Dioxide | 10102-44-0 | 0.03 | -- | -- |
| Nitrous Oxide | 10024-97-2 | 143 | 7 | 5 |
| Water Vapor | 7732-18-5 | 8100 | 400 | 4.7 |
| ORGANICS | | ppmv | ppmv | % |
| Propanone (acetone) | 67-64-1 | 1.40 | 0.37 | 26 |
| Propanol | 71-23-8 | 0.32 | 0.098 | 30 |
| Benzene | 71-43-2 | 0.005 | 0.0003 | 6 |
| Methane | 74-82-8 | < 61 | -- | -- |
| Propanenitrile(acetonitrile) | 75-05-8 | 0.052 | -- | -- |
| Trichlorofluoromethane | 75-69-4 | 0.14 | 0.042 | 30 |
| 2-Butanone | 78-93-3 | 0.22 | 0.010 | 4 |
| Propanenitrile | 107-12-0 | 0.070 | 0.004 | 5 |
| 4-Methyl-2-Pentanone | 108-10-1 | 0.011 | 0.0003 | 3 |
| Toluene | 108-88-3 | 0.0070 | 0.0002 | 3 |
| n-Butanenitrile | 109-74-0 | 0.020 | 0.005 | 24 |
| Tetrahydrofuran | 109-99-9 | 0.36 | 0.19 | 5 |
| 2-Heptanone | 110-43-0 | 0.093 | 0.009 | 10 |
| n-Hexane | 110-54-3 | 0.16 | 0.02 | 11 |
| Pyridine | 110-86-1 | 0.089 | 0.028 | 31 |
| 2-Octanone | 111-13-7 | 0.043 | 0.006 | 13 |
| n-Octane | 111-65-9 | 0.043 | 0.002 | 5 |

Table 4-4. Summary Results of Inorganic and Organic Samples Collected from the Tank 241-BX-104 Headspace in December 1994.¹

| Species | CAS Number | Average | STD | RPD |
|----------------------|------------|---------|-------|-----|
| ORGANICS (continued) | | ppmv | ppmv | % |
| n-Nonane | 111-84-2 | 0.039 | 0.003 | 9 |
| n-Decane | 124-18-5 | 0.037 | 0.003 | 7 |
| n-Heptane | 142-82-5 | 0.067 | 0.011 | 17 |
| 2-Hexanone | 591-78-6 | 0.059 | 0.005 | 8 |
| n-Undecane | 1120-21-4 | 0.26 | 0.01 | 5 |

Notes:

CAS = Chemical Abstract Service

¹Huckaby and Bratzel (1995)

5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-BX-104, and to assess and compare these results against historical information and program requirements.

5.1 ASSESSMENT OF SAMPLING AND ANALYTICAL RESULTS

This section evaluates sampling and analysis factors that may impact interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data. Some of the usual consistency checks were not possible given the limited scope of the analyses.

5.1.1 Field Observations

The Safety Screening (Dukelow et al. 1995) and Organic Complexant Safety (Turner et al. 1995) DQOs both required that vertical profiles of the waste be obtained from two widely spaced risers. This requirement was fulfilled, allowing a spatial examination of the analyte concentrations. The estimated sample recoveries ranged from 50 percent to 99 percent, drawing into question the representativeness of some of the samples. Contamination of the core 127 segment 2A sample by the HHF resulted in this segment being excluded from all mean calculations and other comparisons. Also, sample heterogeneity may have led to precision problems for some of the analytes (e.g. iron). No further anomalies that might limit the use of the data were noted.

5.1.2 Quality Control Assessment

The usual quality control assessment includes an evaluation of the appropriate standard recoveries, matrix spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent quality control tests were conducted on the 1996 core samples, allowing a full assessment regarding the accuracy and precision of the data. As indicated in the SAP, the specific criteria for all QC checks were governed by *Quality Assurance Plan for Activities Conducted by the Analytical Chemistry Laboratory* (Kuhl-Klinger 1995). Quality control results outside these criteria are identified by superscripts in the Appendix A tables for all analytes, both DQO-driven and opportunistic (Kristofzski 1995). The QC results for the primary analytes from the Safety Screening and Organic Complexant Safety DQOs are discussed below.

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, then the analytical results may be biased high or low, respectively. All standard recoveries were within the defined criterion. Total alpha activity had 2 of 14 matrix spikes (66 and 70 percent recovery) slightly below the criterion of 75 to 125 percent recovery. These spikes were probably due to difficulties during sample preparation that resulted in higher mass loading and subsequent self-shielding (Hu 1996). Analytical precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred. Weight percent (wt%) water had one of nine RPDs outside the target level, and one of the five DSC sample pairs showing exothermic reactions had an RPD outside the limits. The analytical results for iron had sample heterogeneity problems that resulted in RPDs above the ≤ 20 percent criterion for several sample pairs. None of the other primary ICP analytes had RPDs outside the limit. The estimated analytes calcium and manganese showed some sample contamination, but this was attributed primarily to low-level contamination from the fusion reagents and processing (Hu 1996). Blank contamination was not a problem for the other primary analytes.

In summary, practically all of the QC results were within the boundaries specified in Kuhl-Klinger (1995). The few discrepancies noted should not impact either the validity or the use of the data.

5.1.3 Data Consistency Checks

Comparisons of different analytical methods can help to assess the consistency and quality of the data. The quantity of data available enabled calculations of mass and charge balances, along with comparison of the ICP phosphorus result with the IC phosphate result. Only the sludge portion of the waste was considered in these comparisons because it comprises 90 percent of the total waste volume.

5.1.3.1 Comparison of Results from Different Analytical Methods. The following data consistency check compares the results from two different analytical methods. The analytical mean results were taken from Table 4-2.

The analytical phosphorus mean by ICP was 2,340 $\mu\text{g/g}$, which represents total phosphorus. The ICP phosphorus mean converts to 7,180 $\mu\text{g/g}$ of phosphate. The IC phosphate result was 8,490 $\mu\text{g/g}$. There is a large variability associated with each of the two means (RSD [mean] phosphorous = 34.9 percent and RSD (mean) phosphate = 54.9 percent). Consequently, in this case, the mean phosphate estimates based on the two methods are not significantly different from each other. This suggests that the phosphorous is 100 percent water soluble as the phosphate ion. The variability between two sets of data can be attributed to difference in instrument and method sensitivity, and measurement uncertainty.

5.1.3.2 Homogenization Test. To evaluate the adequacy of the laboratory homogenization procedure, a sample and duplicate were analyzed from the top and bottom of each homogenized sample of core 126 lower half sludge and core 127 upper half sludge. The RSDs of all tested analytes (Al, Cr, Fe, Na, U and ¹³⁷Cs) from ICP and GEA analyses for these samples were less than 8 percent except for iron (Hu 1996). The results indicated that the homogenization processing was very effective.

5.1.3.3 Mass and Charge Balances. The principal objective in performing mass and charge balances is to determine if the measurements were self-consistent. In calculating the balances, only those analytes listed in Table 4-2 that were estimated ("≈") or detected at a concentration of 1,000 μg/g or greater were considered.

With the exception of sodium, all cations listed in Table 5-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Based on the large endothermic reaction that the samples exhibited near 300 °C (572 °F), aluminum was assumed to exist as Al(OH)₃. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. Phosphorus was assumed to be present entirely as the soluble phosphate ion, based on the fact that the IC phosphate result is greater than the ICP phosphorus result converted to phosphate (see Section 5.1.3.1). The acetate and carbonate data were derived from the total organic carbon and total inorganic carbon analyses, respectively. The anionic analytes listed in Table 5-2 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. The concentrations of cations in Table 5-1, the anions in Table 5-2, and the percent water were ultimately used to calculate the mass balance. The uncertainty estimates (RSDs) associated with each analyte are also given in the tables. The uncertainty estimates for the cation and anion totals, as well as the overall uncertainty given in Table 5-3, were computed by a statistical technique known as the propagation of errors (Nuclear Regulatory Commission 1988).

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from μg/g to wt%.

$$\begin{aligned} \text{Mass balance} &= \text{percent water} + 0.0001 \times \{\text{Total Analyte Concentration}\} \\ &= \text{percent water} + 0.0001 \times \{[\text{Al}(\text{OH})_3] + [\text{CaO}] + [\text{Cr}(\text{OH})_3] + \\ &\quad [\text{FeO}(\text{OH})] + [\text{MnO}(\text{OH})] + [\text{SeO}_2] + [\text{Na}^+] + [\text{UO}_2] + [\text{C}_2\text{H}_3\text{O}_2] + \\ &\quad [\text{CO}_3^{2-}] + [\text{Cl}^-] + [\text{NO}_3^-] + [\text{NO}_2^-] + [\text{PO}_4^{3-}] + [\text{SiO}_3^{2-}] + [\text{SO}_4^{2-}]\}. \end{aligned}$$

The total analyte concentration calculated from the above equation is 605,000 μg/g. The mean wt% water obtained from thermogravimetric analysis reported in Table 4-2 is 29.5 percent, or 295,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 90 percent (Table 5-3).

The following equations demonstrate the derivation of total cations and total anions. The charge balance is the ratio of these two values.

Total cations = $[Na^+]/23.0 = 3,160 \mu\text{eq/g}$

Total anions = $[C_2H_3O_2^-]/59.0 + [CO_3^{2-}]/30.0 + [Cl^-]/35.5 + [NO_3^-]/62.0 + [NO_2^-]/46. + [PO_4^{3-}]/31.7 + [SiO_3^{2-}]/38.1 + [SO_4^{2-}]/48.1 = 2,780 \mu\text{eq/g}.$

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.14. The net charge is $380 \mu\text{eq/g}$.

In summary, the above calculations yield reasonable mass and charge balance values (close to 100 percent for the mass balance and close to 1.0 for the charge balance), given the associated uncertainties with the data indicating that the analytical results are generally self-consistent.

Table 5-1. Cation Mass and Charge Data.

| Analyte | Concentration | Assumed Species | Concentration of Assumed Species | RSD (Mean) | Charge |
|-----------|-----------------|---------------------|----------------------------------|------------|--------|
| | $\mu\text{g/g}$ | | $\mu\text{g/g}$ | % | |
| Aluminum | 115,000 | Al(OH) ₃ | 332,000 | 57.1 | 0 |
| Calcium | ≈ 1,900 | CaO | ≈ 2,660 | 19.7 | 0 |
| Chromium | 6,330 | Cr(OH) ₃ | 12,500 | 63.6 | 0 |
| Iron | 6,400 | FeO(OH) | 10,200 | 57.2 | 0 |
| Manganese | ≈ 1,540 | MnO(OH) | ≈ 2,470 | 66.8 | 0 |
| Selenium | ≈ 1,040 | SeO ₂ | ≈ 1,460 | 22.1 | 0 |
| Sodium | 72,700 | Na ⁺ | 72,700 | 30.6 | 3,160 |
| Uranium | 38,400 | UO ₃ | 46,100 | 42.5 | 0 |
| Total | | | 480,000 | 40.0 | 3,160 |

Table 5-2. Anion Mass and Charge Data.

| Analyte | Concentration | Assumed Species | Concentration of Assumed Species | RSD (Mean) | Charge |
|-----------|-----------------|------------------------------------|----------------------------------|------------|--------|
| | $\mu\text{g/g}$ | | $\mu\text{g/g}$ | % | |
| TOC | 5,210 | $\text{C}_2\text{H}_3\text{O}_2^-$ | 12,800 | 42.1 | -217 |
| TIC | 4,830 | CO_3^{2-} | 24,200 | 35.4 | -807 |
| Chloride | 1,040 | Cl^- | 1,040 | 17.7 | -29.3 |
| Nitrate | 47,800 | NO_3^- | 47,800 | 22.4 | -771 |
| Nitrite | 24,200 | NO_2^- | 24,200 | 28.5 | -526 |
| Phosphate | 8,490 | PO_4^{3-} | 8,490 | 54.9 | -268 |
| Silicate | $\approx 1,830$ | SiO_3^{2-} | $\approx 4,960$ | 15.2 | -130 |
| Sulfate | 1,750 | SO_4^{2-} | 1,750 | 21.2 | -36.4 |
| Total | | | 125,000 | 13.6 | -2,780 |

Table 5-3. Mass Balance Totals.

| Totals | Concentrations | RSD (Mean) |
|-------------------------------|-----------------|------------|
| | $\mu\text{g/g}$ | % |
| Cation total (from Table 5-1) | 480,000 | 40.0 |
| Anion total (from Table 5-2) | 125,000 | 13.6 |
| Water | 295,000 | 51.7 |
| Grand total | 900,000 | 27.3 |

5.2 COMPARISON OF 1986 SAMPLING WITH ANALYTICAL RESULTS

Comparisons between the 1986 results and the 1996 results are included in Table 5-4. The 1986 values were obtained from Table C-1 in Appendix C, while the 1996 results were taken from Table 4-2. Comparisons were performed only for those analytes with estimated or detected values. The 1986 total alpha number was derived by summing the ^{241}Am and $^{239/240}\text{Pu}$ activities.

The ratio between 1986 and 1996 was given in column four. As can be seen in Table 5-4, results for sodium and density agreed quite well, while barium differs by a factor of 42 and silicon by 17. For the rest of the analytes, they agree with each other within a factor of two except aluminum, bismuth, calcium, and TOC.

Table 5-4. Comparison of Data from the 1986 and 1996 Sampling Events.¹

| Analyte | 1986 Result ² | 1996 Result ³ | Ratio (1986/1996) |
|----------------------------|--------------------------|--------------------------|-------------------|
| METALS | µg/g | µg/g | |
| Aluminum | 47,400 | 1.15E+05 | 0.41 |
| Barium | 1,650 | ≈ 38.9 | 42.4 |
| Bismuth | 1,410 | ≈ 551 | 2.56 |
| Calcium | 4,840 | ≈ 1,900 | 2.55 |
| Chromium | 3,790 | 6,330 | 0.60 |
| Iron | 7,340 | 6,400 | 1.15 |
| Lead | 572 | ≈ 946 | 0.60 |
| Manganese | 981 | ≈ 1,540 | 0.64 |
| Phosphorus | 3,760 | ≈ 2,340 | 1.61 |
| Silicon | 32,400 | ≈ 1,830 | 17.70 |
| METALS | µg/g | µg/g | % |
| Sodium | 68,700 | 72,700 | 0.94 |
| Strontium | 61.9 | ≈ 51.1 | 1.21 |
| Uranium | 24,400 | 38,400 | 0.64 |
| Zinc | 112 | ≈ 220 | 0.51 |
| ANIONS | µg/g | µg/g | µg/g |
| Nitrate | 38,500 | 47,800 | 0.81 |
| RADIONUCLIDES | µCi/g | µCi/g | µCi/g |
| Total alpha | 0.970 | 1.28 | 0.76 |
| ¹³⁷ Cs | 99.6 | 73.1 | 1.36 |
| CARBON | µg C/g | µg C/g | µg C/g |
| TOC | 2,250 | 5,210 | 0.43 |
| PHYSICAL PROPERTIES | | | |
| Density | 1.81 g/mL | 1.73 g/mL | 1.05 |

Notes:

¹The historical data have not been validated and should be used with caution.

²Weiss and Schull (1988)

³Hu (1996)

5.3 TANK WASTE PROFILE

According to the estimate of Hanlon (1996), the approximately 81 cm (32 in.) of waste in tank 241-BX-104 consists of 11 kL (3 kgal) of supernatant and 363 kL (96 kgal) of sludge. For the sludge portion, drainable interstitial liquid was calculated to be 114 kL (30 kgal). The photographic montage of the waste surface showed a black sludge surface with small pools of liquid in at least two different locations. The visual descriptions of the samples varied from whitish-gray to black, and all four segments had some drainable liquid associated with them. The TLM (Figure 2-3) followed the estimates of Hanlon (1996) but divided the sludge layer into an upper portion of 208 kL (55 kgal) of unknown waste and a lower portion of 155 kL (41 kgal) of metal waste. Based on this information, the tank waste appears to be somewhat heterogeneous.

Standard statistical analysis of variance (ANOVA) models were fit to the 1996 core/segment data. The results from these models can be used to judge the vertical and horizontal variability in mean analyte concentration. Nested random effects ANOVA models were fit to the analytical data from the sludge and from the drainable liquid. The ANOVA models were fit to analyte concentration data, for those data sets where the measurements were at least 50 percent above the detection limits. For these analytes the detection limit was used as the measured concentration.

The p-value, from the ANOVA models, is compared to a standard significance level ($\alpha = 0.05$). If it is less than 0.05, then the analyte means are significantly different from each other. However, if a p-value is greater than 0.05, the analyte means are not significantly different from each other. In the following paragraphs, the p-values are in parentheses.

A one-way ANOVA model was fit with the drainable liquid data from the two segments of core 126. Drainable liquid data from core 127, segment 2 were not included in the fit because the core was contaminated with HHF. There were significant differences in the mean concentrations between the two core 126 segments, in terms of vertical variability, for 53 percent (17 out of 32) of the analytes: arsenic (0.014), boron (0.010), calcium (0.001), chromium (0.004), molybdenum (0.011), nickel (0.001), phosphorus (0.014), potassium (0.039), silicon (0.003), nitrate (0.001), nitrite (0.004), phosphate (0.020), sulfate (0.020), TOC (0.003), TIC (0.007), TC (0.005), and total alpha activity (0.009).

A nested random effects model was fit to the core/segment sludge data. There were significant differences in the mean concentrations between the two segments, in terms of vertical variability, for 10 percent (3 out of 29) of the analytes: lead (0.006), zinc (0.017) and total alpha activity (0.004). There were significant differences in the mean concentration between the two core samples, horizontal variability, for 14 percent (4 out of 29) of the analytes; i.e., for aluminum (0.048), sodium (0.003), nitrite (0.041), and sulfate (0.031).

In summary, the visual descriptions of the samples, the photo montage, the Hanlon (1996) estimates, and the statistical results of the drainable liquid all indicated a certain degree of tank heterogeneity. However, the statistical results for the sludge portion of the tank waste indicated a general uniformity.

5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS

The total inventory estimate of the tank contents from the HDW Model Rev. 3 (Agnew et al. [1996a]) are compared with the analytical results of the sludge overall mean from the 1996 sampling event (Table 5-5). This total tank inventory estimate is based on a model called Hanford Defined Waste model that consists of several elements: tank layer model, supernatant mixing model, about 50 HDWs (Hanford Defined Wastes), and the WSTRS (waste status and transaction record summary) transaction data from 1994 to present. The total inventory estimate for this tank is the sum of the 155 kL (41 kgal) of metal waste predicted by the TLM solid model and the 220 kL (58 kgal) of SMM composite inventory.

In general, there is reasonably good agreement between the HDW Model Rev. 3 (Agnew et al. 1996a) estimate and the analytical results. In Table 5-5, the ratio between the estimate and analytical results is given in column four as an indicator of the comparison. Note that 10 of the 16 analytes have a ratio within or near a factor of 2. The rest of them are within or close to a factor of 5, except aluminum. The estimate for ^{137}Cs and density are very close to the analytical results--within 10%. The worst analyte in the comparison is aluminum with a ratio of 0.1. One interesting trend observed is that all the anions are overestimated and all the cations, except sodium and uranium, are underestimated with respect to analytical results. Another trend observed is that the ratios of the anions (except sulfate) and TIC average 1.5 and are close to the ratio of the weight percent water. If this trend is associated with solubility, and if the weight percent water estimate is improved, presumably the anion ratio between the estimate and analytical results can have better agreement. The objective of this comparison is to see the ratio indicator converged to one, so that the model can be used as a tool to characterize the tank and reduce the number of sampling events.

An effort was made to compare the predicted 155-kL (41-kgal) metal waste layer on the bottom with the analytical result. Core 126 segment 2 lower half data were selected to compare with the content of metal waste estimated by the HDW Model Rev. 3 (Agnew et al. 1996a). As shown in Table 5-6, the agreement between the estimate and analytical results for the metal waste layer is not as good as the total inventory comparison; however, the major metal analytes in the metal waste layer such as sodium, uranium, calcium, and iron show better agreement than the total inventory comparison. In addition, the agreement between the estimate and analytical results for the analytes such as nitrate, nitrite, phosphate, and aluminum in the metal waste layer is much worse than the total inventory comparison. This suggests that a great deal of the SMM layer composites were mingled together with the bottom metal waste layer.

Table 5-5. Comparison of Total Inventory Estimate¹ with 1996 Analytical Results Tank

| Analyte | Total Inventory Estimate | Sludge Overall Mean (Analytical Results) | Ratio (Estimate/Analytical) |
|----------------------------|--------------------------|--|-----------------------------|
| METALS | | | |
| | $\mu\text{g/g}$ | $\mu\text{g/g}$ | |
| Aluminum | 11,700 | 115,000 | 0.10 |
| Calcium | 1,300 | 1,900 | 0.68 |
| Chromium | 864 | 6,330 | 0.14 |
| Iron | 1,890 | 6,400 | 0.30 |
| Silicon | 685 | 1,880 | 0.36 |
| Sodium | 1.08E+05 | 72,700 | 1.48 |
| Uranium | 1.27E+05 | 38,400 | 3.31 |
| ANIONS | | | |
| | $\mu\text{g/g}$ | $\mu\text{g/g}$ | |
| Chloride | 2,100 | 1,040 | 2.02 |
| Nitrate | 90,500 | 47,800 | 1.87 |
| Nitrite | 30,000 | 24,200 | 1.24 |
| Phosphate | 12,600 | 8,490 | 1.48 |
| Sulfate | 9,020 | 1,750 | 5.15 |
| RADIONUCLIDES | | | |
| | $\mu\text{Ci/g}$ | $\mu\text{Ci/g}$ | |
| ¹³⁷ Cs | 76.9 | 73.1 | 1.05 |
| CARBON | | | |
| | $\mu\text{g C/g}$ | $\mu\text{g C/g}$ | |
| Total inorganic carbon | 7,680 | 4,830 | 1.59 |
| PHYSICAL PROPERTIES | | | |
| Weight percent water | 46.3 % | 29.5 % | 1.57 |
| Density | 1.55 g/mL | 1.73 g/mL | 0.90 |

Note:

¹Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3 (Agnew et al. 1996a)

Table 5-6. Comparison of Metal Waste Layer¹ with 1996 Analytical Results.

| Analyte | Metal Waste 1 Layer Estimate | Core 126 Segment 2 Lower Half | Ratio (Estimate/Analytical) |
|----------------------------|------------------------------|-------------------------------|-----------------------------|
| METALS | | | |
| | <i>µE/g</i> | <i>µE/g</i> | |
| Aluminum | 0 | 1.53E+05 | 0 |
| Calcium | 1,930 | 1,485 | 1.30 |
| Chromium | 36.9 | 1,355 | 0.027 |
| Iron | 3,790 | 2,193 | 1.73 |
| Silicon | 24.9 | 2,354 | 0.011 |
| Sodium | 6.63E+04 | 57,847 | 1.15 |
| Uranium | 2.71E+05 | 100,680 | 2.69 |
| ANIONS | | | |
| | <i>µE/g</i> | <i>µE/g</i> | |
| Chloride | 26 | 900 | 0.029 |
| Nitrate | 2,220 | 43,000 | 0.052 |
| Nitrite | 241 | 16,850 | 0.014 |
| Phosphate | 21,700 | 4,550 | 4.77 |
| Sulfate | 4,510 | 1,500 | 3.01 |
| RADIONUCLIDES | | | |
| | <i>µCi/g</i> | <i>µCi/g</i> | |
| ¹³⁷ Cs | 0.481 | n/a | n/a |
| CARBON | | | |
| | <i>µg C/g</i> | <i>µg C/g</i> | |
| Total inorganic carbon | 2,592 | 2,880 | 0.9 |
| PHYSICAL PROPERTIES | | | |
| Weight percent water | 44.4 % | 22.15 % | 2.00 |
| Density | 1.75 g/mL | 2.01 g/mL | 0.87 |

Note:

¹Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev.3 (Agnew et al. 1996a)

5.5 EVALUATION OF PROGRAM REQUIREMENTS

The 1996 core sampling event was governed by two DQOs: Safety Screening (Dukelow et al. 1995), and Organic Complexant Safety (Turner et al. 1995). The Safety Screening DQO lists requirements for examining the waste in each Hanford Site underground waste tank to identify safety problems and to evaluate the tank for placement on the Watch List. The Organic Complexant Safety DQO addresses the possibility of an exothermic reaction between organic complexant and precipitated nitrate or nitrite salts. These issues were integrated by the SAP (Gretzinger 1996) into a list of required analytical tests and their respective decision thresholds. Section 5.5.1 discusses each issue as identified in the DQOs, while Section 5.1.2 examines previous screenings of the tank for high heat conditions as modeled by *Hanford Tank Chemical and Radionuclide Inventories, HDW Model Rev. 3* (Agnew et al. 1996a) and *Topical Report on Heat Removal Characteristics of Waste Storage Tanks* (Kummerer 1994).

5.5.1 Safety Screening Evaluation

Data criteria identified in the Safety Screening DQO were used to assess the safety of the waste in tank 241-BX-104. The requirement that vertical profiles of the waste be obtained from at least two widely spaced risers was met. The four required primary safety analyses include DSC to evaluate the fuel content, total alpha activity to determine the criticality potential, a visual check of drainable liquid samples for the presence of a separable organic layer, and determination of the lower flammability limit of the gases in the tank headspace. For each of the required analyses, a decision criteria threshold was established by the DQO which, if exceeded, may warrant further investigation to assure the safety of the tank.

Data criteria identified in the Organic Complexant Safety DQO are used to assess the possibility of an exothermic reaction between precipitated nitrate or nitrite salts and organic complexants. The required number of profiles to be obtained from the tank waste is based on information such as that from historical sampling or prior sampling activities. If specific information is not available, two vertical profiles will be obtained from widely spaced risers. Tank 241-BX-104 was evaluated in accordance with the Organic Complexant Safety DQO because the tank was identified as possibly containing > 3 wt% TOC by a review of waste transfer records (Babad and Turner 1993). The primary analytes required by this DQO are DSC, TGA to determine the moisture content, and TOC to estimate its contribution to the total fuel content. Decision criteria thresholds were also established by the DQO for these analytes.

Table 5-7 lists the applicable safety issues, decision variables and thresholds, and the mean analytical result from the 1996 push-mode core sampling event for the Safety Screening and Organic Complexant Safety DQOs.

Table 5-7. Decision Variables and Criteria for the Safety Screening and Organic Complexant Safety Data Quality Objectives.

| Safety Issue | Primary Decision Variable | Decision Criteria Threshold | Analytical Results |
|-----------------------|---------------------------|---|--|
| Ferrocyanide/organics | Total fuel content | < -480 J/g | All observed exothermic reactions \geq -100 J/g. All one-sided 95% confidence interval upper limits > -480 J/g. |
| Organic complexants | Total organic carbon | Sludge and Drainable Liquid: > 30,000 $\mu\text{g C/g}$ | Sludge: Highest 15,464 $\mu\text{g C/g}$ with mean 8,286 $\mu\text{g C/g}$. Drainable liquid: Highest 7,891 $\mu\text{g C/g}$ with mean 6,263 $\mu\text{g C/g}$. |
| Organic content | Visual organic layer | Presence/Not present | No separable organic layer noted |
| Moisture content | Weight percent water | < 17% | Sludge: Lowest 10 wt% with mean 29.5 wt%, Drainable liquids: Lowest 58.4 wt% with mean 59.1 wt% |
| Criticality | Total alpha activity | Sludge > 30.4 $\mu\text{Ci/g}^1$, Drainable liquids > 47.3 $\mu\text{Ci/g}$ | Sludge: Highest 2.54 $\mu\text{Ci/g}$ with mean 1.28 $\mu\text{Ci/g}$, Drainable liquids: Highest 4.43E-04 $\mu\text{Ci/g}$ with mean 2.63E-04 $\mu\text{Ci/g}$ |
| Flammable gas | Flammable gas | > 25% of the LFL | 0% of the LFL |

Note:

¹The decision criterion threshold listed in the DQO was 1 g/L. Total alpha was reported in $\mu\text{Ci/g}$ rather than g/L. To convert the notification limit for total alpha into the same units as those used by the laboratory, it was assumed that all alpha decay originated from ²³⁹Pu. Using the specific activity of ²³⁹Pu (0.0615 Ci/g), the decision criteria thresholds for each of the sludge samples may be converted by using the specific densities associated with the samples. The samples with the highest density were the primary result from sludge sample 96-02982 and drainable liquid sample 96-2990. This density of 2.02 g/mL and 1.30 g/mL were converted to a decision threshold of 30.4 $\mu\text{Ci/g}$ and 47.3 $\mu\text{Ci/g}$, representing the lowest threshold for any of the sludge and drainable liquid samples respectively. The stoichiometry is presented below.

$$\left(\frac{1 \text{ g}}{\text{L}} \right) \left(\frac{1 \text{ L}}{10^3 \text{ mL}} \right) \left(\frac{1}{\text{density}} \frac{\text{mL}}{\text{g}} \right) \left(\frac{0.0615 \text{ Ci}}{1 \text{ g}} \right) \left(\frac{10^6 \mu\text{Ci}}{1 \text{ Ci}} \right) = \frac{61.5}{\text{density}} \frac{\mu\text{Ci}}{\text{g}}$$

Both the Safety Screening and Organic Complexant Safety DQOs have established a decision criteria threshold of -480 J/g (dry weight basis) for the DSC analyses. All of the following results are also given on a dry weight basis. Exothermic reactions were noted in two of the sludge samples and in three of the drainable liquid samples, but they were all below the DQO limit. For the sludge samples, the single highest exothermic reaction was -36.7 J/g and the upper limit of a one-sided 95 percent confidence interval was -45.0 J/g. For the drainable liquid samples, the single highest exothermic reaction was -74.0 J/g and the upper limit of a one-sided 95 percent upper confidence interval was -174 J/g.

The Organic Complexant Safety DQO requires TOC as a primary analyte, while the Safety Screening DQO requires it as a secondary procedure whenever the DSC analysis exceeds its decision criteria threshold. The TOC results in dry weight basis, along with the mean value, standard deviation of mean, are listed in Table 5-8. The mean TGA data were used to calculate the dry weight basis TOC for each sample. The drainable liquid data were converted to $\mu\text{g C/g}$ by dividing the TOC value with density. For the HHF-contaminated sample, the calculated TOC value is based on the measured TGA data and will give the upper limit due to the HHF dilution effect. As shown in Table 5-8, the highest value is 15,500 $\mu\text{g C/g}$ with overall mean 6,085 $\mu\text{g C/g}$. The upper limit of the one-sided 95 percent confidence interval of the mean was calculated for each sample and listed in the last column of Table 5-8. The upper limit of a one-sided 95 percent confidence interval is 23,028 $\mu\text{g C/g}$, which comes from the core 127 segment 1 upper half sample; it is well below the Organic Complexant Safety DQO decision criteria thresholds of 30,000 $\mu\text{g C/g}$ (i.e., 3 wt% dry weight basis).

Table 5-8. TOC Results in Dry Weight Basis.

| Sample Number | Core: Segment | Sample ($\mu\text{g/g}$) | Duplicate ($\mu\text{g/g}$) | RPD (%) | Mean ($\mu\text{g/g}$) | Std Dev of mean | 95% CL ($\mu\text{g/g}$) |
|---------------|-----------------------|----------------------------|-------------------------------|---------|--------------------------|-----------------|----------------------------|
| 96-2979 | 126-1W | 7,856 | 7,211 | 9 | 7,533 | 322 | 9,568 |
| 96-2981 | 126-2U | 1,244 | 1,176 | 6 | 1,210 | 34 | 1,425 |
| 96-2982 | 126-2L | 771 | 874 | 13 | 823 | 51 | 1,147 |
| 96-2983 | 127-1U | 14,308 | 16,692 | 15 | 15,500 | 1192 | 23,028 |
| 96-2984 | 127-1L | 9,439 | 8,579 | 10 | 9,009 | 430 | 11,723 |
| 96-2985 | 127-2W ² | 3,007 | 3,399 | 12 | 3,203 | 196 | 4,441 |
| 96-2989 | 126-1D ¹ | 7,700 | 8,082 | 5 | 7,891 | 191 | 9,098 |
| 96-2990 | 126-2D ¹ | 4,172 | 4,305 | 3 | 4,239 | 67 | 4,660 |
| 96-2992 | 127-2D ^{1,2} | 5,654 | 5,069 | 11 | 5,362 | 292 | 7,208 |

Notes:

CL = confidence limit

¹Drainable liquid data was converted to $\mu\text{g/g}$ by dividing the $\mu\text{g/mL}$ by the density.

²HHF contamination.

The Safety Screening DQO requires a visual check of liquid samples for the presence of a separable organic layer. No separable organic layer was noted in any of the liquid samples.

For the sludge portion of the waste, two of the sample means for weight percent water were below the Organic Complexant Safety DQO decision threshold of 17 percent. However, secondary analyses are only required if both the fuel and moisture decision limits are violated for a given subsegment.

The potential for criticality can be assessed from the total alpha activity data. The safety screening notification limit is 1 g/L. Because the laboratory reported total alpha activity in units of $\mu\text{Ci/g}$, the 1 g/L threshold was converted to 41 $\mu\text{Ci/g}$, assuming a density of 1.5 g/mL. If the analytical density result exceeds 1.5 g/mL, then the threshold is adjusted according to the equation given in the Table 5-7 footnote. Because all of the drainable liquid density results were below 1.5 g/mL, the decision limit of 41 $\mu\text{Ci/g}$ applies. Because all of the sludge densities were greater than 1.5 g/mL, their values were adjusted, with the lowest decision threshold being 30.4 $\mu\text{Ci/g}$ for the sample with a density of 2.02 g/mL. The highest individual result for either the sludge or drainable liquid samples was 2.24 $\mu\text{Ci/g}$. The overall tank means were 1.28 $\mu\text{Ci/g}$ for the sludge samples and 2.63E-04 $\mu\text{Ci/g}$ for the drainable liquid samples. The upper limit of a one-sided 95 percent confidence interval for the sludge and drainable liquid samples were 2.53 $\mu\text{Ci/g}$ and 5.86E-04 $\mu\text{Ci/g}$, respectively. Thus, all analytical and confidence interval results were well below their respective Safety Screening DQO decision criteria thresholds.

The flammability of the gas in the tank headspace is an additional Safety Screening DQO consideration. The requirement is that any flammable gas present must be ≤ 25 percent of the LFL. The analytical result was 0 percent of the LFL (see Section 4.1.3).

5.5.2 Tank 241-BX-104 Heat Load

Another factor in assessing tank safety is the heat generation from radioactive decay and the resultant temperature increase of the waste. The HTCE estimate of heat load was 100 W (342 Btu/hr), and the estimate by Kummerer (1994) is 6,208 W (21,200 Btu/hr). Both of these estimates were well below the 11,700-W (40,000-Btu/hr) design specification for single-shell tanks (Bergmann 1991). Because an upper temperature limit has been exhibited (Section 2.4.3), it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-BX-104 was push-mode core sampled in January 1996 for the purposes of safety screening and organic complexant analyses. The Safety Screening and Organic Complexant Safety DQOs governed the sampling and analysis of the waste. The safety issues evaluated by the two DQOs included energetics to determine the fuel content, TOC, the presence of a separable organic layer in the liquid samples, weight percent water, total alpha activity to assess criticality, and flammable gas concentration. In addition, the SAP required the laboratory to perform ICP and IC analyses for lithium and bromide to determine whether or not any samples were contaminated by HHF. Results for opportunistic metals and anions were obtained during these analyses. All samples were analyzed at the PNNL 325 Analytical Chemistry Laboratory.

Comparisons were made between the analytical results and the decision criteria thresholds of the Safety Screening and Organic Complexant Safety DQOs. All analytical results and one-sided 95 percent upper confidence interval limits were below the decision criteria thresholds specified in the SAP. No exothermic reactions above -74.0 J/g were observed in any of the samples, and the highest one-sided 95 percent confidence interval upper limit was -174 J/g, well below the DQO limit of -480 J/g. The mean TOC results for the sludge and drainable liquid samples were $6,213$ $\mu\text{g C/g}$ and $5,830$ $\mu\text{g C/mL}$, respectively. The highest TOC one-sided 95 percent confidence interval upper limits for the sludge and drainable liquid samples were $20,270$ $\mu\text{g C/g}$ and $18,300$ $\mu\text{g C/mL}$, respectively. All results were below the decision thresholds of $30,000$ $\mu\text{g C/g}$. No visible organic layer was present in the drainable liquid samples. The weight percent water results for two of the sludge subsegments were below the Organic Complexant Safety DQO decision threshold of 17 percent. However, secondary analyses are only required if both the fuel and moisture decision limits are violated for a given subsegment. The highest individual value for total alpha activity was 2.24 $\mu\text{Ci/g}$, and the highest one-sided 95 percent confidence interval upper limit was 2.53 $\mu\text{Ci/g}$. All total alpha activity values were at least an order of magnitude below their safety screening thresholds.

The flammability of the gas in the tank headspace is an additional Safety Screening DQO consideration. The decision threshold is that any flammable gas present must be ≤ 25 percent of the LFL. The analytical result was 0 percent of the LFL.

The HTCE estimate of the tank heat load was 100 W (342 Btu/hr), while the estimate based on the headspace temperature was $6,208$ W ($21,200$ Btu/hr). Both estimates were below the $11,700$ -W ($40,000$ -Btu/hr) threshold (Bergmann 1991). Because the tank exhibits an upper temperature limit, it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

Hydrostatic head fluid with a lithium bromide tracer was used during core sampling operations. Contamination over 50 percent occurred in segment 2 of core 127. Thus, the analytical results from this segment were excluded from the overall mean calculation in the tank inventory estimate.

Tank 241-BX-104's headspace was sampled in December 1994 for gases and vapors to address flammability and industrial hygiene concerns. It was determined that no headspace constituents exceeded the flammability notification limits, but that ammonia, measured to be 235 parts per million by volume (ppmv) in dry air, exceeded the 150 ppmv industrial hygiene notification limit specified in the current Vapor Sampling Analysis Plan (Buckley 1996). However, because the ammonia is in the tank headspace and not in the breathing zone, it will not impact worker health.

Overall, the tank can be considered "safe" with respect to the tank safety program criteria, because none of the analytical results exceeds the threshold limit of the Safety Screening and Organic Safety DQOs. However, the analytical results and the appearance of the samples indicate that the tank contents are heterogeneous. Because Core 127 segment 2 was contaminated by HHF, not enough results were available to compare and characterize the metal waste layer for trend analysis. It is recommended that future core sampling events include historical DQO analysis so that enough data will be available for trend analysis and model study.

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APPENDIX A

ANALYTICAL RESULTS FROM 1996 CORE SAMPLING

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A.0 ANALYTICAL RESULTS FROM 1996 CORE SAMPLING

A.1 INTRODUCTION

Appendix A reports the chemical, radiochemical and physical characteristics of tank 241-BX-104 in table form and in terms of the specific concentrations of metals, ions, radionuclides, and physical properties.

Each data table lists the following: laboratory sample identification, sample origin (core/segment/subsegment), an original and duplicate result for each sample, a sample mean, a mean for the tank in which both core means are weighted equally, an RSD (mean), and a projected tank inventory for the particular analyte using the weighted mean and the appropriate conversion factors. The projected tank inventory column is not applicable to the DSC or the density data. The data are listed in standard notation for values greater than 0.001 and less than 100,000. Values outside these limits are listed in scientific notation.

The tables are numbered A-1 through A-56. A description of the units and symbols used in the analyte tables and the references used in compiling the analytical data (Hu 1996) are found in the List of Terms and Section 7.0, respectively. For information on sampling rationale, locations, and descriptions of sampling events, see Section 3.0.

A.2 ANALYTE TABLE DESCRIPTION

The "Sample Number" column lists the laboratory sample for which the analyte was measured.

Column two specifies the core and segment from which each sample was derived.

Column three specifies the subsegment or whole segment for which the analyte was measured.

The Result and Duplicate columns are self-explanatory. The "Sample Mean" column is the average of the result and duplicate values. All values, including those below the detection level (indicated by the less-than symbol, <) and those that were estimated (indicated by the estimated symbol, ≈) were averaged in calculating the sample means. The estimated values are those that were recorded above the instrument detection limit, but were less than 10 times the estimated quantitation limit. If the result and duplicate values were both nondetected, estimated, or detected, then the mean is expressed as a nondetected, estimated, or detected value, respectively. If one of the two values is nondetected and one is estimated, the sample mean is expressed as an estimated value. Similarly, if one of the two values is estimated and the other is detected, the sample mean is expressed as a detected result. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded

up in some cases and rounded down in others. This is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

The overall (or analyte concentration) means for the waste in tank 241-BX-104 were calculated as described below.

The drainable liquid means were calculated by simply averaging the sample means from the two core 126 segments. Similar to the discussion above regarding the sample and duplicate means, if 50 percent or more of the individual sample and duplicate results were estimated or detected, then the overall mean was expressed as an estimated or detected value, respectively. If greater than 50 percent of the individual results were nondetected or estimated, then the overall mean was expressed as a nondetected or estimated value, respectively.

To obtain the overall weighted mean for the sludge portion of the tank contents, the individual sample result and duplicate pairs were first averaged. The sample means within a given subsegment (upper half, lower half, or whole) were then averaged to obtain a subsegment mean. The subsegment means within a given segment were then averaged to obtain a segment mean, the segment means within a given core were averaged to obtain a core mean, and finally the two core means were averaged to obtain the overall mean. As a note, not all of these steps were necessary for each analyte or for each subsegment, but the procedure to be followed is the same.

The discussion above concerning the designation of the drainable liquid overall mean as a nondetected, estimated, or detected value also applies to the sludge data. Two analytes from the sludge portion had nondetected, estimated, and detected results. Because 50 percent of the individual results for uranium were detected, the overall mean was considered a detect. Because 50 percent of the individual zirconium results were nondetected, the overall mean was considered a nondetect.

Relative standard deviations of the mean were computed for analytes following the same rules differentiating nondetected, estimated, and detected means. If the overall mean for a given analyte was either estimated or detected, then an RSD was also calculated for that analyte using all the available data.

The projected inventory is the product of the overall analyte concentration mean, the volume of tank waste (363 kL or 11 kL for the sludge or drainable liquid portions, respectively), the density, where applicable (1.73 g/mL and 1.29 g/mL for the sludge or drainable liquid portions, respectively), and the appropriate conversion factors. The inventory bases for the calculation are $5.89\text{E}+08$ g and $3.45\text{E}+07$ mL for sludge and drainable liquid, respectively.

As discussed in Section 4.1.4, HHF contamination precluded the use of the analytical data from core 127 segment 2 for data comparison; however, the data will be used to evaluate against the safety program criteria. The results are reported in the following tables for informational purposes only, and are identified with a superscripted "1" after the sample number. They were not factored into the calculation of the overall mean estimates

The four quality control parameters assessed on the tank 241-BX-104 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. These were summarized in Section 5.1.2. More specific information is provided in the following appendix tables. Sample and duplicate pairs in which any of the QC parameters were outside their specified limits are superscripted in column 6 as follows:

- QC:a -- indicates that the standard recovery was below the QC range.
- QC:b -- indicates that the standard recovery was above the QC range.
- QC:c -- indicates that the spike recovery was below the QC range.
- QC:d -- indicates that the spike recovery was above the QC range.
- QC:e -- indicates that the RPD was greater than the QC limit range.
- QC:f -- indicates blank contamination.

Table A-1. Tank 241-BX-104 Analytical Results: Aluminum.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | 1.626E+05 | 1.715E+05 | 1.671E+05 | 1.15E+05 | 57.1 | 67,700 |
| 96-02981 | 126:2 | Upper 1/2 | 2.352E+05 | 2.328E+05 | 2.340E+05 | | | |
| 96-02980 | | Lower 1/2 | 1.486E+05 | 1.632E+05 | 1.559E+05 | | | |
| 96-02982 | | | 1.503E+05 | 1.481E+05 | 1.492E+05 | | | |
| 96-02983 | 127:1 | Upper 1/2 | 39,789 | 38,585 | 39,187 | | | |
| 96-02984 | | Lower 1/2 | 60,693 | 59,972 | 60,330 | | | |
| 96-02985 ¹ | 127:2 | Whole | 1.728E+05 | 1.891E+05 | 1.810E+05 | | | |
| 96-02986 ¹ | | | 1.728E+05 | 1.889E+05 | 1.809E+05 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | 2,805.7 | 2,809.6 | 2,807.7 | 2,840 | 1.1 | 98.0 |
| 96-02990 | 126:2 | DL | 2,825.6 | 2,914.7 | 2,870.2 | | | |
| 96-02992 ¹ | 127:2 | DL | 532.9 | 541.1 | 537.0 | | | |

Table A-2. Tank 241-BX-104 Analytical Results: Arsenic.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 1,000 | < 746 | < 873 | < 546 | N/A | < 322 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 266 | ≈ 319 | ≈ 293 | | | |
| 96-02980 | | Lower 1/2 | ≈ 203 | ≈ 244 | ≈ 224 | | | |
| 96-02982 | | Lower 1/2 | < 584 | < 820 | < 702 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 214 | < 173 | < 194 | | | |
| 96-02984 | | Lower 1/2 | < 724 | < 753 | < 739 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 839 | < 724 | < 782 | | | |
| 96-02986 ¹ | 127:2 | Whole | ≈ 316 | ≈ 332 | ≈ 324 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 7.7 | ≈ 7.8 | ≈ 7.8 | ≈ 8.65 | 10.1 | ≈ 0.298 |
| 96-02990 | 126:2 | DL | ≈ 9.7 | ≈ 9.3 | ≈ 9.5 | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 4.5 | ≈ 4.2 | ≈ 4.4 | | | |

Table A-3. Tank 241-BX-104 Analytical Results: Barium.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|-----------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 36.5 | ≈ 29 | ≈ 33 | ≈ 38.9 | 27.1 | ≈ 22.9 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 17 | < 33.9 | ≈ 25 | | | |
| 96-02980 | | Lower 1/2 | < 24.2 | < 22.4 | < 23.3 | | | |
| 96-02982 | | | < 21.2 | < 29.8 | < 25.5 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 49 | ≈ 45 | ≈ 47 | | | |
| 96-02984 | | Lower 1/2 | ≈ 51 | ≈ 51 | ≈ 51 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 37 | ≈ 36 | ≈ 37 | | | |
| 96-02986 ¹ | | | ≈ 30 | ≈ 34 | ≈ 32 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 0.7 | ≈ 0.7 | ≈ 0.7 ^{oc:f} | ≈ 0.650 | 12.0 | ≈ 0.0224 |
| 96-02990 | 126:2 | DL | ≈ 0.6 | ≈ 0.5 | ≈ 0.6 ^{oc:f} | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 0.7 | ≈ 0.7 | ≈ 0.7 ^{oc:f} | | | |

Table A-4. Tank 241-BX-104 Analytical Results: Beryllium.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 18.3 | < 13.6 | < 16.0 | < 13.4 | N/A | < 7.89 |
| 96-02981 | 126:2 | Upper 1/2 | < 7.17 | < 17.0 | < 12.1 | | | |
| 96-02980 | | Lower 1/2 | < 12.1 | < 11.2 | < 11.7 | | | |
| 96-02982 | | | < 10.6 | < 14.9 | < 12.8 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 13.4 | < 10.8 | < 12.1 | | | |
| 96-02984 | | Lower 1/2 | < 13.2 | < 13.7 | < 13.5 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 15.3 | < 13.2 | < 14.3 | | | |
| 96-02986 ¹ | | | < 13.3 | < 12.4 | < 12.9 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 0.390 | < 0.390 | < 0.390 | < 0.488 | N/A | < 0.0168 |
| 96-02990 | 126:2 | DL | < 0.780 | < 0.390 | < 0.585 | | | |
| 96-02992 ¹ | 127:2 | DL | < 0.818 | < 0.408 | < 0.613 | | | |

Table A-5. Tank 241-BX-104 Analytical Results: Bismuth.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | ≈ 843 | ≈ 907 | ≈ 875 | ≈ 551 | 25.0 | ≈ 325 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | ≈ 486 | ≈ 519 | ≈ 503 | | | |
| 96-02982 | | | ≈ 492 | ≈ 465 | ≈ 479 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 334 | ≈ 318 | ≈ 326 | | | |
| 96-02984 | | Lower 1/2 | ≈ 617 | ≈ 654 | ≈ 636 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 319 | ≈ 350 | ≈ 335 | | | |
| 96-02986 ¹ | | | < 266 | ≈ 251 | ≈ 259 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 7.3 | ≈ 7.2 | ≈ 7.3 | ≈ 6.90 | 5.8 | ≈ 0.238 |
| 96-02990 | 126:2 | DL | ≈ 6.7 | ≈ 6.2 | ≈ 6.5 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.45 | ≈ 3.2 | ≈ 4.3 | | | |

Table A-6. Tank 241-BX-104 Analytical Results: Boron.

| Sample Number | Core: Segment | Sub-segment | Result µB/g | Duplicate µB/g | Sample Mean µB/g | Overall Mean µB/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|-----------------------|----------------------|-----------------|---------------------------|
| Soil/s: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 183 | < 136 | < 160 | ≈ 219 | 15.7 | ≈ 129 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 171 | ≈ 505 | ≈ 338 ^{QCcf} | | | |
| 96-02980 | | Lower 1/2 | ≈ 309 | ≈ 264 | ≈ 287 ^{QCcf} | | | |
| 96-02982 | | | < 106 | < 149 | < 128 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 293 | ≈ 325 | ≈ 309 ^{QCcf} | | | |
| 96-02984 | | Lower 1/2 | < 132 | < 137 | < 135 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 153 | < 132 | < 143 | | | |
| 96-02986 ¹ | | | ≈ 235 | ≈ 236 | ≈ 236 ^{QCcf} | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | 25.1 | 25.4 | 25.3 ^{QCcc} | 28.4 | 11.0 | 0.980 |
| 96-02990 | 126:2 | DL | 30.9 | 32.1 | 31.5 ^{QCcc} | | | |
| 96-02992 ¹ | 127:2 | DL | 37.0 | 37.7 | 37.4 ^{QCcc} | | | |

Table A-7. Tank 241-BX-104 Analytical Results: Cadmium.

| Sample Number | Core Segment | Sub-segment | Result #g/g | Duplicate #g/g | Sample Mean #g/g | Overall Mean #g/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|----------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 274 | < 203 | < 239 ^{ccf} | < 150 | N/A | < 88.4 |
| 96-02981 | 126:2 | Upper 1/2 | < 21.5 | < 50.9 | < 36.2 | | | |
| 96-02980 | | Lower 1/2 | < 36.4 | < 33.6 | < 35.0 | | | |
| 96-02982 | | | < 159 | < 224 | < 192 ^{ccf} | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 40.1 | ≈ 35 | ≈ 38 | | | |
| 96-02984 | | Lower 1/2 | ≈ 211 | ≈ 288 | ≈ 250 ^{ccf} | | | |
| 96-02985 ¹ | 127:2 | Whole | < 229 | < 197 | < 213 | | | |
| 96-02986 ¹ | | | < 39.9 | < 37.2 | < 38.6 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 2.2 | ≈ 1.8 | ≈ 2.0 | ≈ 1.70 | 19.4 | ≈ 0.0587 |
| 96-02990 | 126:2 | DL | ≈ 2.0 | ≈ 0.7 | ≈ 1.4 | | | |
| 96-02992 ¹ | 127:2 | DL | < 1.36 | < 0.680 | < 1.02 | | | |

Table A-8. Tank 241-BX-104 Analytical Results: Calcium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | ≈ 3,450 | ≈ 2,214 | ≈ 2,832 ^{OC1} | ≈ 1,900 | 19.7 | ≈ 1,120 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 1,568 | ≈ 1,746 | ≈ 1,657 ^{OC1} | | | |
| 96-02980 | | Lower 1/2 | ≈ 905 | ≈ 1,520 | ≈ 1,210 ^{OC1} | | | |
| 96-02982 | | | ≈ 1,729 | ≈ 1,786 | ≈ 1,758 ^{OC1} | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 1,235 | ≈ 1,059 | ≈ 1,147 | | | |
| 96-02984 | | Lower 1/2 | ≈ 2,027 | ≈ 2,067 | ≈ 2,047 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 4,495 | ≈ 1,621 | ≈ 3,058 | | | |
| 96-02986 ¹ | | | ≈ 1,124 | ≈ 1,146 | ≈ 1,135 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | ≈ 25.9 | ≈ 25.2 | ≈ 25.6 ^{OC1} | ≈ 19.1 | 33.9 | ≈ 0.659 |
| 96-02990 | 126:2 | DL | ≈ 12.9 | ≈ 12.3 | ≈ 12.6 ^{OC1} | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 7.0 | ≈ 6.8 | ≈ 6.9 ^{OC1} | | | |

Table A-9. Tank 241-BX-104 Analytical Results: Cerium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 456 | < 339 | < 398 | < 322 | N/A | < 190 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | < 242 | < 224 | < 233 | | | |
| 96-02982 | | | < 265 | < 373 | < 319 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 272 | ≈ 269 | ≈ 271 | | | |
| 96-02984 | | Lower 1/2 | ≈ 354 | ≈ 365 | ≈ 360 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 381 | < 329 | < 355 | | | |
| 96-02986 ¹ | | | < 266 | < 248 | < 257 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 2.60 | < 2.60 | < 2.60 | < 3.25 | N/A | < 0.112 |
| 96-02990 | 126:2 | DL | < 5.20 | < 2.60 | < 3.90 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.45 | < 2.72 | < 4.09 | | | |

Table A-10. Tank 241-BX-104 Analytical Results: Chromium.

| Sample Number | Core: Segment | Sub-segment | Result #g/g | Duplicate #g/g | Sample Mean #g/g | Overall Mean #g/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | 3,699 | 4,015 | 3,857 | 6,330 | 63.6 | 3,730 |
| 96-02981 | 126:2 | Upper 1/2 | 1,665 | 1,714 | 1,690 | | | |
| 96-02980 | | Lower 1/2 | 1,245 | 1,378 | 1,312 | | | |
| 96-02982 | | | 1,368 | 1,430 | 1,399 | | | |
| 96-02983 | 127:1 | Upper 1/2 | 13,550 | 13,553 | 13,552 | | | |
| 96-02984 | | Lower 1/2 | 6,371 | 6,362 | 6,367 | | | |
| 96-02985 ¹ | 127:2 | Whole | 2,085 | 2,279 | 2,182 | | | |
| 96-02986 ¹ | | | 2,155 | 2,334 | 2,245 | | | |
| Liquids: acid digest | | | #g/mL | #g/mL | #g/mL | #g/mL | % | kg |
| 96-02989 | 126:1 | DL | 2,629.0 | 2,597.4 | 2,613.2 | 2,970 | 12.1 | 102 |
| 96-02990 | 126:2 | DL | 3,375.5 | 3,292.0 | 3,333.8 | | | |
| 96-02992 ¹ | 127:2 | DL | 1,789.1 | 1,767.6 | 1,778.4 | | | |

Table A-11. Tank 241-BX-104 Analytical Results: Cobalt.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 183 | < 136 | < 160 | < 134 | N/A | < 78.9 |
| 96-02981 | 126:2 | Upper 1/2 | < 71.7 | < 170 | < 121 | | | |
| 96-02980 | | Lower 1/2 | < 121 | < 112 | < 117 | | | |
| 96-02982 | | | < 106 | < 149 | < 128 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 134 | < 108 | < 121 | | | |
| 96-02984 | | Lower 1/2 | < 132 | < 137 | < 135 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 153 | < 132 | < 143 | | | |
| 96-02986 ¹ | | | < 133 | < 124 | < 129 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 1.30 | < 1.30 | < 1.30 | < 1.63 | N/A | < 0.0562 |
| 96-02990 | 126:2 | DL | < 2.60 | < 1.30 | < 1.95 | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.73 | < 1.36 | < 2.05 | | | |

Table A-12. Tank 241-BX-104 Analytical Results: Copper.

| Sample Number | Core: Segment | Sub-segment | Result $\mu\text{g/g}$ | Duplicate $\mu\text{g/g}$ | Sample Mean $\mu\text{g/g}$ | Overall Mean $\mu\text{g/g}$ | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|------------------------|---------------------------|-----------------------------|------------------------------|--------------|------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 183 | < 136 | < 160 | < 167 | N/A | < 98.4 |
| 96-02981 | 126:2 | Upper 1/2 | < 71.7 | < 170 | < 121 | | | |
| 96-02980 | | Lower 1/2 | \approx 138 | < 112 | \approx 125 | | | |
| 96-02982 | | | < 106 | < 149 | < 128 | | | |
| 96-02983 | 127:1 | Upper 1/2 | \approx 330 | \approx 170 | \approx 250 | | | |
| 96-02984 | | Lower 1/2 | < 132 | < 137 | < 135 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 153 | < 132 | < 143 | | | |
| 96-02986 ¹ | | | < 133 | < 124 | < 129 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | \approx 2.1 | \approx 2.0 | \approx 2.1 | \approx 2.52 | 17.6 | \approx 0.0869 |
| 96-02990 | 126:2 | DL | < 3.90 | < 1.95 | < 2.93 | | | |
| 96-02992 ¹ | 127:2 | DL | < 4.09 | < 2.04 | < 3.07 | | | |

Table A-13. Tank 241-BX-104 Analytical Results: Dysprosium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 183 | < 136 | < 160 | < 134 | N/A | < 78.9 |
| 96-02981 | 126:2 | Upper 1/2 | < 71.7 | < 170 | < 121 | | | |
| 96-02980 | | Lower 1/2 | < 121 | < 112 | < 117 | | | |
| 96-02982 | | | < 106 | < 149 | < 128 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 134 | < 108 | < 121 | | | |
| 96-02984 | | Lower 1/2 | < 132 | < 137 | < 135 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 153 | < 132 | < 143 | | | |
| 96-02986 ¹ | | | < 133 | < 124 | < 129 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 1.30 | < 1.30 | < 1.30 | < 1.63 | N/A | < 0.0562 |
| 96-02990 | 126:2 | DL | < 2.60 | < 1.30 | < 1.95 | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.73 | < 1.36 | < 2.05 | | | |

Table A-14. Tank 241-BX-104 Analytical Results: Europium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 365 | < 271 | < 318 | < 268 | N/A | < 158 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | < 242 | < 224 | < 233 | | | |
| 96-02982 | | | < 212 | < 298 | < 255 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 268 | < 216 | < 242 | | | |
| 96-02984 | | Lower 1/2 | < 263 | < 274 | < 269 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 305 | < 263 | < 284 | | | |
| 96-02986 ¹ | | | < 266 | < 248 | < 257 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 2.60 | < 2.60 | < 2.60 | < 3.25 | N/A | < 0.112 |
| 96-02990 | 126:2 | DL | < 5.20 | < 2.60 | < 3.90 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.45 | < 2.72 | < 4.09 | | | |

Table A-15. Tank 241-BX-104 Analytical Results: Iron.

| Sample Number | Core Segment | Sub-segment | Result #g/g | Duplicate #g/g | Sample Mean #g/g | Overall Mean #g/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|-------------|----------------|------------------------|-------------------|--------------|------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | 3,689 | 4,048 | 3,869 | 6,400 | 57.2 | 3,770 |
| 96-02981 | 126:2 | Upper 1/2 | 1,702 | 3,061 | 2,382 ^{OC:1} | | | |
| 96-02980 | | Lower 1/2 | 3,373 | 2,148 | 2,761 ^{OC:1} | | | |
| 96-02982 | | | 1,249 | 2,003 | 1,626 ^{OC:1} | | | |
| 96-02983 | 127:1 | Upper 1/2 | 16,053 | 14,179 | 15,116 ^{OC:1} | | | |
| 96-02984 | | Lower 1/2 | 4,148 | 4,486 | 4,317 | | | |
| 96-02985 ¹ | 127:2 | Whole | 4,251 | 4,031 | 4,141 | | | |
| 96-02986 ¹ | | | 3,342 | 3,883 | 3,613 ^{OC:1} | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 2.0 | ≈ 2.2 | ≈ 2.1 ^{OC:1} | ≈ 2.05 | 2.4 | ≈ 0.0707 |
| 96-02990 | 126:2 | DL | < 2.60 | ≈ 1.4 | ≈ 2.0 ^{OC:1} | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.73 | < 1.36 | < 2.05 ^{OC:1} | | | |

Table A-16. Tank 241-BX-104 Analytical Results: Lanthanum.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 183 | < 136 | < 160 | < 138 | N/A | < 81.3 |
| 96-02981 | 126:2 | Upper 1/2 | < 71.7 | < 170 | < 121 | | | |
| 96-02980 | | Lower 1/2 | < 121 | < 112 | < 117 | | | |
| 96-02982 | | | < 106 | < 149 | < 128 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 140 | ≈ 127 | ≈ 134 | | | |
| 96-02984 | | Lower 1/2 | < 132 | < 137 | < 135 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 153 | < 132 | < 143 | | | |
| 96-02986 ¹ | | | < 133 | < 124 | < 129 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 1.30 | < 1.30 | < 1.30 | < 1.63 | N/A | < 0.0562 |
| 96-02990 | 126:2 | DL | < 2.60 | < 1.30 | < 1.95 | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.73 | < 1.36 | < 2.05 | | | |

Table A-17. Tank 241-BX-104 Analytical Results: Lead.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 1,280 | < 949 | < 1,110 | ≈ 946 | 10.5 | ≈ 557 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 715 | ≈ 781 | ≈ 748 | | | |
| 96-02980 | | Lower 1/2 | ≈ 649 | ≈ 690 | ≈ 670 | | | |
| 96-02982 | | | < 743 | < 1,040 | < 892 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 840 | ≈ 1,096 | ≈ 968 | | | |
| 96-02984 | | Lower 1/2 | < 921 | < 958 | < 940 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 1,070 | < 921 | < 996 | | | |
| 96-02986 ¹ | | | ≈ 678 | ≈ 713 | ≈ 696 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 13.0 | < 13.0 | < 13.0 ^{cc/d} | < 16.3 | N/A | < 0.562 |
| 96-02990 | 126:2 | DL | < 26.0 | < 13.0 | < 19.5 ^{cc/d} | | | |
| 96-02992 ¹ | 127:2 | DL | < 27.3 | < 13.6 | < 20.5 ^{cc/d} | | | |

Table A-18. Tank 241-BX-104 Analytical Results: Magnesium.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 365 | < 271 | < 318 | < 270 | N/A | < 159 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | < 242 | < 224 | < 233 | | | |
| 96-02982 | | | < 212 | < 298 | < 255 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 268 | ≈ 231 | ≈ 250 | | | |
| 96-02984 | | Lower 1/2 | < 263 | < 274 | < 269 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 305 | < 263 | < 284 | | | |
| 96-02986 ¹ | | | < 266 | < 248 | < 257 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 2.60 | < 2.60 | < 2.60 | < 3.25 | N/A | < 0.112 |
| 96-02990 | 126:2 | DL | < 5.20 | < 2.60 | < 3.90 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.45 | < 2.72 | < 4.07 | | | |

Table A-19. Tank 241-BX-104 Analytical Results: Manganese.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|--------------|-------------|----------------|-------------------|----------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | ≈ 772 | ≈ 763 | ≈ 768 | ≈ 1,540 | 66.8 | ≈ 907 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 97 | ≈ 753 | ≈ 430 ^{ccf} | | | |
| 96-02980 | | Lower 1/2 | ≈ 832 | ≈ 535 | ≈ 684 ^{ccf} | | | |
| 96-02982 | | | ≈ 112 | ≈ 223 | ≈ 168 | | | |
| 96-02983 | 127:1 | Upper 1/2 | 3,823 | 3,967 | 3,895 ^{ccf} | | | |
| 96-02984 | | Lower 1/2 | ≈ 1,033 | ≈ 1,076 | ≈ 1,055 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 803 | ≈ 799 | ≈ 801 | | | |
| 96-02986 ¹ | | | ≈ 791 | ≈ 829 | ≈ 810 ^{ccf} | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 1.30 | < 1.30 | < 1.30 | < 1.63 | N/A | < 0.0562 |
| 96-02990 | 126:2 | DL | < 2.60 | < 1.30 | < 1.95 | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.73 | < 1.36 | < 2.05 | | | |

Table A-20. Tank 241-BX-104 Analytical Results: Molybdenum.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-------------------------------|--------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 110 | < 81.3 | < 95.7 | < 80.5 | N/A | < 47.4 |
| 96-02981 | 126:2 | Upper 1/2 | < 43.0 | < 102 | < 72.5 | | | |
| 96-02980 | | Lower 1/2 | < 72.7 | < 67.3 | < 70.0 | | | |
| 96-02982 | | | ≈ 66 | < 89.5 | ≈ 78 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 80.3 | < 64.9 | < 72.6 | | | |
| 96-02984 | | Lower 1/2 | < 79.0 | < 82.1 | < 80.6 | | | |
| 96-02985 ¹ | | Whole | < 91.6 | < 79.0 | < 85.3 | | | |
| 96-02986 ¹ | | | < 79.7 | < 74.5 | < 77.1 | | | |
| Liquids: acid digested | | | | | | | | |
| 96-02989 | 126:1 | DL | 31.8 | 31.2 | 31.5 ^{90°C} | 32.9 | 4.3 | 1.14 |
| 96-02990 | 126:2 | DL | 34.3 | 34.3 | 34.3 ^{90°C} | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 16.2 | 16.1 | ≈ 16.2 ^{90°C} | | | |

Table A-21. Tank 241-BX-104 Analytical Results: Neodymium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 365 | < 271 | < 318 | < 300 | N/A | < 177 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | < 242 | < 224 | < 233 | | | |
| 96-02982 | | | < 212 | < 298 | < 255 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 380 | ≈ 353 | ≈ 367 | | | |
| 96-02984 | | Lower 1/2 | ≈ 269 | < 274 | ≈ 272 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 305 | < 263 | < 284 | | | |
| 96-02986 ¹ | | | < 266 | < 248 | < 257 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 2.60 | < 2.60 | < 2.60 | < 3.25 | N/A | < 0.112 |
| 96-02990 | 126:2 | DL | < 5.20 | < 2.60 | < 3.90 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.45 | < 2.72 | < 4.09 | | | |

Table A-22. Tank 241-BX-104 Analytical Results: Nickel.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|--|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| Results cannot be reported due to the fusion reagents and the crucible material used for the fusion (Hu 1996). | | | | | | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | 14.0 | 13.5 | 13.8 | ≈ 8.90 | 54.9 | ≈ 0.307 |
| 96-02990 | 126:2 | DL | ≈ 4.2 | ≈ 3.8 | ≈ 4.0 | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 2.6 | ≈ 2.3 | ≈ 2.5 | | | |

Table A-23. Tank 24-i-BX-104 Analytical Results: Palladium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 1,100 | < 813 | < 957 | < 805 | N/A | < 474 |
| 96-02981 | 126:2 | Upper 1/2 | < 430 | < 1,020 | < 725 | | | |
| 96-02980 | | Lower 1/2 | < 727 | < 673 | < 700 | | | |
| 96-02982 | | | < 637 | < 895 | < 766 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 803 | < 649 | < 726 | | | |
| 96-02984 | | Lower 1/2 | < 790 | < 821 | < 806 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 916 | < 790 | < 853 | | | |
| 96-02986 ¹ | | | < 797 | < 745 | < 771 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 13.0 | < 13.0 | < 13.0 | < 16.3 | N/A | < 0.562 |
| 96-02990 | 126:2 | DL | < 26.0 | < 13.0 | < 19.5 | | | |
| 96-02992 ¹ | 127:2 | DL | < 27.3 | < 13.6 | < 20.5 | | | |

Table A-24. Tank 241-BX-104 Analytical Results: Phosphorus.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | ≈ 2,456 | ≈ 2,706 | ≈ 2,581 | ≈ 2,340 | 34.9 | ≈ 1,380 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 794 | ≈ 871 | ≈ 833 | | | |
| 96-02980 | | Lower 1/2 | ≈ 1,547 | ≈ 2,016 | ≈ 1,782 | | | |
| 96-02982 | | | ≈ 1,666 | ≈ 1,725 | ≈ 1,696 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 890 | ≈ 552 | ≈ 721 | | | |
| 96-02984 | | Lower 1/2 | ≈ 4,818 | ≈ 4,745 | ≈ 4,782 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 1,613 | ≈ 1,584 | ≈ 1,599 | | | |
| 96-02986 ¹ | | | ≈ 1,506 | ≈ 1,652 | ≈ 1,579 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | 1,960.4 | 1,984.6 | 1,972.5 | 1,780 | 10.8 | 61.4 |
| 96-02990 | 126:2 | DL | 1,543.6 | 1,630.9 | 1,587.3 | | | |
| 96-02992 ¹ | 127:2 | DL | 1,221.0 | 1,267.5 | 1,244.3 | | | |

Table A-25. Tank 241-BX-104 Analytical Results: Potassium.

| Sample Number | Core: Segment | Sub-segment | Result #g/g | Duplicate #g/g | Sample Mean #g/g | Overall Mean #g/g | RSD (Mean) % | Projected Inventory kg |
|--|---------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| Results cannot be reported due to the fusion reagents and the crucible material used for the fusion (Hu 1996). | | | | | | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | 1,923.3 | 1,937.1 | 1,930.2 | 2,010 | 3.8 | 69.3 |
| 96-02990 | 126:2 | DL | 2,051.7 | 2,112.2 | 2,082.0 ^{ccr} | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 969.6 | 991.9 | ≈ 980.8 | | | |

Table A-26. Tank 241-BX-104 Analytical Results: Rhodium.

| Sample Number | Core: Segment | Sub-segment | Result | Duplicate | Sample Mean | Overall Mean | RSD (Mean) | Projected Inventory |
|-----------------------|---------------|-------------|---------|-----------|-------------|--------------|------------|---------------------|
| Solids: fusion | | | µg/g | µg/g | µg/g | µg/g | % | kg |
| 96-02979 | 126:1 | Whole | < 1,100 | < 813 | < 957 | < 805 | N/A | < 474 |
| 96-02981 | 126:2 | Upper 1/2 | < 430 | < 1,020 | < 725 | | | |
| 96-02980 | | Lower 1/2 | < 727 | < 673 | < 700 | | | |
| 96-02982 | | | < 637 | < 895 | < 766 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 803 | < 649 | < 726 | | | |
| 96-02984 | | Lower 1/2 | < 790 | < 821 | < 806 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 916 | < 790 | < 853 | | | |
| 96-02986 ¹ | | | < 797 | < 745 | < 771 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | ≈ 6.5 | ≈ 5.8 | ≈ 6.2 | ≈ 6.85 | 9.9 | ≈ 0.236 |
| 96-02990 | 126:2 | DL | ≈ 8.6 | ≈ 6.4 | ≈ 7.5 | | | |
| 96-02992 ¹ | 127:2 | DL | < 8.2 | < 4.1 | < 6.2 | | | |

Table A-27. Tank 241-BX-104 Analytical Results: Ruthenium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 365 | < 271 | < 318 | < 268 | N/A | < 158 |
| 96-02981 | 126:2 | Upper 1/2 | < 143 | < 339 | < 241 | | | |
| 96-02980 | | Lower 1/2 | < 242 | < 224 | < 233 | | | |
| 96-02982 | | | < 212 | < 298 | < 255 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 268 | < 216 | < 242 | | | |
| 96-02984 | | Lower 1/2 | < 263 | < 273 | < 268 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 305 | < 263 | < 284 | | | |
| 96-02986 ¹ | | | < 266 | < 248 | < 257 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | ≈ 8.1 | ≈ 8.1 | ≈ 8.1 | ≈ 7.70 | 5.2 | ≈ 0.266 |
| 96-02990 | 126:2 | DL | ≈ 7.5 | ≈ 7.1 | ≈ 7.3 | | | |
| 96-02992 ¹ | 127:2 | DL | < 5.5 | ≈ 3.8 | ≈ 4.7 | | | |

Table A-28. Tank 241-BX-104 Analytical Results: Selenium.

| Sample Number | Core: Segment | Sub-segment | Result µB/g | Duplicate µB/g | Sample Mean µB/g | Overall Mean µB/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 1,830 | < 1,360 | < 1,600 | ≈ 1,040 | 22.1 | ≈ 613 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 802 | ≈ 871 | ≈ 837 | | | |
| 96-02980 | | Lower 1/2 | ≈ 781 | ≈ 832 | ≈ 807 | | | |
| 96-02982 | | | < 1,060 | < 1,490 | < 1,280 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 284 | ≈ 248 | ≈ 266 | | | |
| 96-02984 | | Lower 1/2 | < 1,320 | < 1,370 | < 1,350 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 1,530 | < 1,320 | < 1,430 | | | |
| 96-02986 ¹ | | | ≈ 727 | ≈ 718 | ≈ 723 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 13.0 | < 13.0 | < 13.0 ^{9c,d} | < 16.3 | N/A | < 0.562 |
| 96-02990 | 126:2 | DL | < 26.0 | < 13.0 | < 19.5 ^{9c,d} | | | |
| 96-02992 ¹ | 127:2 | DL | < 27.3 | < 13.6 | < 20.5 ^{9c,d} | | | |

Table A-29. Tank 241-BX-104 Analytical Results: Silicon.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 1,826 | ≈ 1,840 | ≈ 1,833 | ≈ 1,880 | 15.2 | ≈ 1,110 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 2,492 | ≈ 2,945 | ≈ 2,719 | | | |
| 96-02980 | | Lower 1/2 | < 1,212 | ≈ 2,999 | ≈ 2,106 | | | |
| 96-02982 | | | ≈ 2,842 | ≈ 2,362 | ≈ 2,602 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 1,717 | ≈ 1,581 | ≈ 1,649 | | | |
| 96-02984 | | Lower 1/2 | ≈ 1,578 | ≈ 1,457 | ≈ 1,518 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 1,745 | ≈ 1,588 | ≈ 1,667 | | | |
| 96-02986 ¹ | | | ≈ 1,695 | ≈ 1,835 | ≈ 1,765 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | ≈ 53.2 | ≈ 52.9 | ≈ 53.1 | ≈ 82.4 | 35.6 | ≈ 2.84 |
| 96-02990 | 126:2 | DL | ≈ 114.9 | ≈ 108.4 | ≈ 111.7 | | | |
| 96-02992 ¹ | 127:2 | DL | ≈ 81.9 | ≈ 80.2 | ≈ 81.1 | | | |

Table A-30. Tank 241-BX-104 Analytical Results: Silver.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 54.8 | ≈ 44 | ≈ 49 | < 56.5 | N/A | < 33.3 |
| 96-02981 | 126:2 | Upper 1/2 | < 35.9 | < 84.9 | < 60.4 | | | |
| 96-02980 | | Lower 1/2 | < 60.6 | < 56.1 | < 58.4 | | | |
| 96-02982 | | | < 31.8 | < 44.7 | < 38.3 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 66.9 | < 54.1 | < 60.5 | | | |
| 96-02984 | | Lower 1/2 | ≈ 62 | ≈ 61 | ≈ 62 | | | |
| 96-02985 ¹ | | Whole | ≈ 58 | ≈ 47 | ≈ 53 | | | |
| 96-02986 ¹ | | | < 66.5 | < 62.0 | < 64.3 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 0.390 | < 0.390 | < 0.390 | < 0.488 | N/A | < 0.0168 |
| 96-02990 | 126:2 | DL | < 0.780 | < 0.390 | < 0.585 | | | |
| 96-02992 ¹ | 127:2 | DL | < 0.818 | < 0.408 | < 0.613 | | | |

Table A-31. Tank 241-BX-104 Analytical Results: Sodium.

| Sample Number | Core: Segment | Sub-segment | Result #B/g | Duplicate #B/g | Sample Mean #B/g | Overall Mean #B/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|-----------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | 50,864 | 53,958 | 52,411 | 72,700 | 30.6 | 42,800 |
| 96-02981 | 126:2 | Upper 1/2 | 39,719 | 41,627 | 40,673 | | | |
| 96-02980 | | Lower 1/2 | 53,636 | 59,876 | 56,756 | | | |
| 96-02982 | | | 57,607 | 60,272 | 58,940 | | | |
| 96-02983 | 127:1 | Upper 1/2 | 93,934 | 98,387 | 96,161 | | | |
| 96-02984 | | Lower 1/2 | 92,952 | 93,335 | 93,144 | | | |
| 96-02985 ¹ | 127:2 | Whole | 33,431 | 36,603 | 35,017 | | | |
| 96-02986 ¹ | | | 35,634 | 38,240 | 36,937 ^{0.5} | | | |
| Liquids: acid digest | | | #g/mL | #g/mL | #g/mL | #g/mL | % | kg |
| 96-02989 | 126:1 | DL | 139,419.7 | 138,550.9 | 138,985.3 | 140,000 | 0.8 | 4,830 |
| 96-02990 | 126:2 | DL | 140,601.4 | 141,864.9 | 141,233.2 | | | |
| 96-02992 ¹ | 127:2 | DL | 75,092.3 | 76,269.3 | 75,680.8 | | | |

Table A-32. Tank 241-BX-104 Analytical Results: Strontium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 54.8 | ≈ 44 | 49.4 | ≈ 51.1 | 17.3 | ≈ 30.1 |
| 96-02981 | 126:2 | Upper 1/2 | < 21.5 | < 50.9 | < 36.2 | | | |
| 96-02980 | | Lower 1/2 | ≈ 79 | ≈ 88 | ≈ 84 | | | |
| 96-02982 | | | ≈ 88 | ≈ 85 | ≈ 87 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 40.1 | < 32.4 | < 36.3 | | | |
| 96-02984 | | Lower 1/2 | ≈ 58 | ≈ 58 | ≈ 58 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 52 | ≈ 49 | ≈ 51 | | | |
| 96-02986 ¹ | | | ≈ 44 | ≈ 48 | ≈ 46 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 0.390 | < 0.390 | < 0.390 | < 0.488 | N/A | < 0.0168 |
| 96-02990 | 126:2 | DL | < 0.780 | < 0.390 | < 0.585 | | | |
| 96-02992 ¹ | 127:2 | DL | < 0.818 | < 0.408 | < 0.613 | | | |

Table A-33. Tank 241-BX-104 Analytical Results: Tellurium.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|--------------|-------------|----------------|-------------------|-------------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 1,830 | < 1,360 | < 1,600 | < 1,340 | N/A | < 789 |
| 96-02981 | 126:2 | Upper 1/2 | < 717 | < 1,700 | < 1,210 | | | |
| 96-02980 | | Lower 1/2 | < 1,210 | < 1,120 | < 1,170 | | | |
| 96-02982 | | | < 1,060 | < 1,490 | < 1,280 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 1,340 | < 1,080 | < 1,210 | | | |
| 96-02984 | | Lower 1/2 | < 1,320 | < 1,370 | < 1,350 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 1,530 | < 1,320 | < 1,430 | | | |
| 96-02986 ¹ | | | < 1,330 | < 1,240 | < 1,290 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 13.0 | < 13.0 | < 13.0 ^{QC-14} | < 16.3 | N/A | < 0.562 |
| 96-02990 | 126:2 | DL | < 26.0 | < 13.0 | < 19.5 ^{QC-14} | | | |
| 96-02992 ¹ | 127:2 | DL | < 27.3 | < 13.6 | < 20.5 ^{QC-14} | | | |

Table A-34. Tank 241-BX-104 Analytical Results: Thallium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 1,830 | < 1,360 | < 1,600 | < 1,340 | N/A | < 789 |
| 96-02981 | 126:2 | Upper 1/2 | < 717 | < 1,700 | < 1,210 | | | |
| 96-02980 | | Lower 1/2 | < 1,210 | < 1,120 | < 1,170 | | | |
| 96-02982 | | | < 1,060 | < 1,490 | < 1,280 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 1,340 | < 1,080 | < 1,210 | | | |
| 96-02984 | | Lower 1/2 | < 1,320 | < 1,370 | < 1,350 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 1,530 | < 1,320 | < 1,430 | | | |
| 96-02986 ¹ | | | < 1,330 | < 1,240 | < 1,290 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 13.0 | < 13.0 | < 13.0 | < 16.3 | N/A | < 0.562 |
| 96-02990 | 126:2 | DL | < 26.0 | < 13.0 | < 19.5 | | | |
| 96-02992 ¹ | 127:2 | DL | < 27.3 | < 13.6 | < 20.5 | | | |

Table A-35. Tank 241-BX-104 Analytical Results: Tin.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|------------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 3,650 | < 2,711 | < 3,180 | < 2,680 | N/A | < 1,580 |
| 96-02981 | 126:2 | Upper 1/2 | < 1,430 | < 3,390 | < 2,410 | | | |
| 96-02980 | | Lower 1/2 | < 2,420 | < 2,240 | < 2,330 | | | |
| 96-02982 | | | < 2,120 | < 2,980 | < 2,550 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 2,680 | < 2,160 | < 2,420 | | | |
| 96-02984 | | Lower 1/2 | < 2,630 | < 2,740 | < 2,690 | | | |
| 96-02985 ¹ | | Whole | < 3,050 | < 2,630 | < 2,840 | | | |
| 96-02986 ¹ | | | < 2,660 | < 2,480 | < 2,570 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 26.0 | < 26.0 | < 26.0 ^{QC-d} | < 32.5 | N/A | < 1.12 |
| 96-02990 | 126:2 | DL | < 52.0 | < 26.0 | < 39.0 ^{QC-d} | | | |
| 96-02992 ¹ | 127:2 | DL | < 54.5 | < 27.2 | < 40.9 ^{QC-d} | | | |

Table A-36. Tank 241-BX-104 Analytical Results: Titanium.

| Sample Number | Core Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | < 91.3 | < 67.8 | < 79.6 | < 67.3 | N/A | < 39.6 |
| 96-02981 | 126:2 | Upper 1/2 | < 35.9 | < 84.9 | < 60.4 | | | |
| 96-02980 | | Lower 1/2 | < 60.6 | ≈ 66 | ≈ 63.3 | | | |
| 96-02982 | | | < 53.1 | < 74.6 | < 63.9 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 66.9 | < 54.1 | < 60.5 | | | |
| 96-02984 | | Lower 1/2 | < 65.8 | < 68.4 | < 67.1 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 76.3 | < 65.8 | < 71.1 | | | |
| 96-02986 ¹ | | | < 66.5 | < 62.0 | < 64.3 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 0.650 | < 0.650 | < 0.650 | < 0.813 | N/A | < 0.0280 |
| 96-02990 | 126:2 | DL | < 1.30 | < 0.650 | < 0.975 | | | |
| 96-02992 ¹ | 127:2 | DL | < 1.36 | < 0.680 | < 1.02 | | | |

Table A-37. Tank 241-BX-104 Analytical Results: Tungsten.

| Sample Number | Core: Segment | Sub-segment | Result | Duplicate | Sample Mean | Overall Mean | RSD (Mean) | Projected Inventory |
|-----------------------|---------------|-------------|---------|-----------|----------------------|--------------|------------|---------------------|
| Solids: fusion | | | µg/g | µg/g | µg/g | µg/g | % | kg |
| 96-02979 | 126:1 | Whole | < 1,830 | < 1,360 | < 1,600 | < 1,340 | N/A | < 789 |
| 96-02981 | 126:2 | Upper 1/2 | < 717 | < 1,700 | < 1,210 | | | |
| 96-02980 | | Lower 1/2 | < 1,210 | < 1,120 | < 1,170 | | | |
| 96-02982 | | | < 1,060 | < 1,490 | < 1,280 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 1,340 | < 1,080 | < 1,210 | | | |
| 96-02984 | | Lower 1/2 | < 1,320 | < 1,370 | < 1,350 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 1,530 | < 1,320 | < 1,430 | | | |
| 96-02986 ¹ | | | < 1,330 | < 1,240 | < 1,290 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | ≈ 40.3 | ≈ 37.2 | ≈ 38.8 ^{CC} | ≈ 40.4 | 4.0 | ≈ 1.39 |
| 96-02990 | 126:2 | DL | < 52.0 | ≈ 32.0 | ≈ 42.0 ^{CC} | | | |
| 96-02992 ¹ | 127:2 | DL | < 54.5 | < 27.2 | < 40.9 ^{CC} | | | |

Table A-38. Tank 241-BX-104 Analytical Results: Uranium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | ≈ 19,190 | ≈ 19,249 | ≈ 19,220 | 38,400 | 42.5 | 22,600 |
| 96-02981 | 126:2 | Upper 1/2 | < 2,870 | < 6,790 | < 4,830 | | | |
| 96-02980 | | Lower 1/2 | 98,321 | 1.0511E+05 | 1.0172E+05 | | | |
| 96-02982 | | | 1.0067E+05 | 98,619 | 99,645 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 20,788 | ≈ 20,517 | ≈ 20,653 | | | |
| 96-02984 | | Lower 1/2 | 60,480 | 61,157 | 60,819 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 32,637 | ≈ 33,786 | ≈ 33,212 | | | |
| 96-02986 ¹ | | | ≈ 30,231 | ≈ 31,895 | ≈ 31,063 | | | |
| Liquids; acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 52.0 | < 52.0 | < 52.0 | < 65.0 | N/A | < 2.24 |
| 96-02990 | 126:2 | DL | < 104 | < 52.0 | < 78.0 | | | |
| 96-02992 ¹ | 127:2 | DL | < 109 | < 54.4 | < 81.7 | | | |

Table A-39. Tank 241-BX-104 Analytical Results: Vanadium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 54.8 | < 40.7 | < 47.8 | ≈ 45.2 | 7.3 | ≈ 26.6 |
| 96-02981 | 126:2 | Upper 1/2 | < 21.5 | < 50.9 | < 36.2 | | | |
| 96-02980 | | Lower 1/2 | ≈ 39 | ≈ 43 | ≈ 41 | | | |
| 96-02982 | | | ≈ 46 | ≈ 53 | ≈ 50 | | | |
| 96-02983 | 127:1 | Upper 1/2 | < 40.1 | < 32.4 | < 36.3 | | | |
| 96-02984 | | Lower 1/2 | ≈ 55 | ≈ 56 | ≈ 56 | | | |
| 96-02985 ¹ | | Whole | < 45.8 | < 39.5 | < 42.7 | | | |
| 96-02986 ¹ | | | < 39.9 | < 37.2 | < 38.6 | | | |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL | µg/mL | % | kg |
| 96-02989 | 126:1 | DL | < 1.95 | < 1.95 | < 1.95 | < 2.48 | N/A | < 0.0856 |
| 96-02990 | 126:2 | DL | < 3.90 | ≈ 2.1 | ≈ 3.0 | | | |
| 96-02992 ¹ | 127:2 | DL | < 4.09 | < 2.04 | < 3.07 | | | |

Table A-40. Tank 241-BX-104 Analytical Results: Yttrium.

| Sample Number | Core: Segment | Sub-segment | Result #B/g | Duplicate #B/g | Sample Mean #B/g | Overall Mean #B/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| 96-02979 | 126:1 | Whole | < 36.5 | < 27.1 | < 31.8 | < 36.5 | N/A | < 21.5 |
| 96-02981 | 126:2 | Upper 1/2 | < 14.3 | < 33.9 | < 24.1 | | | |
| 96-02980 | | Lower 1/2 | < 24.2 | < 22.4 | < 23.3 | | | |
| 96-02982 | | | < 21.2 | < 29.8 | < 25.5 | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 55 | ≈ 46 | ≈ 51 | | | |
| 96-02984 | | Lower 1/2 | ≈ 39 | ≈ 39 | ≈ 39 | | | |
| 96-02985 ¹ | 127:2 | Whole | < 30.5 | < 26.3 | < 28.4 | | | |
| 96-02986 ¹ | | | < 26.6 | < 24.8 | < 25.7 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 0.260 | < 0.260 | < 0.260 | < 0.325 | N/A | < 0.0112 |
| 96-02990 | 126:2 | DL | < 0.520 | < 0.260 | < 0.390 | | | |
| 96-02992 ¹ | 127:2 | DL | < 0.545 | < 0.272 | < 0.409 | | | |

Table A-41. Tank 241-BX-104 Analytical Results: Zinc.

| Sample Number | Core Segment | Sub-segment | Result $\mu\text{g/g}$ | Duplicate $\mu\text{g/g}$ | Sample Mean $\mu\text{g/g}$ | Overall Mean $\mu\text{g/g}$ | RSD (Mean) % | Projected Inventory kg |
|-----------------------|--------------|-------------|------------------------|---------------------------|-----------------------------|------------------------------|--------------|------------------------|
| 96-02979 | 126:1 | Whole | ≈ 320 | ≈ 179 | $\approx 250^{\text{ocf}}$ | ≈ 220 | 14.7 | ≈ 130 |
| 96-02981 | 126:2 | Upper 1/2 | ≈ 105 | ≈ 209 | $\approx 157^{\text{ocf}}$ | | | |
| 96-02980 | | Lower 1/2 | ≈ 113 | ≈ 114 | $\approx 114^{\text{ocf}}$ | | | |
| 96-02982 | | | ≈ 110 | ≈ 313 | $\approx 212^{\text{ocf}}$ | | | |
| 96-02983 | 127:1 | Upper 1/2 | ≈ 289 | ≈ 201 | $\approx 245^{\text{ocf}}$ | | | |
| 96-02984 | | Lower 1/2 | ≈ 302 | ≈ 149 | ≈ 226 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 214 | ≈ 127 | ≈ 171 | ≈ 1.4 | 14.8 | ≈ 0.0483 |
| 96-02986 ¹ | | | ≈ 80 | ≈ 78 | $\approx 79^{\text{ocf}}$ | | | |
| Liquids: acid digest | | | $\mu\text{g/mL}$ | $\mu\text{g/mL}$ | $\mu\text{g/mL}$ | | | |
| 96-02989 | 126:1 | DL | ≈ 1.0 | ≈ 1.3 | $\approx 1.2^{\text{ocf}}$ | ≈ 1.4 | 14.8 | ≈ 0.0483 |
| 96-02990 | 126:2 | DL | ≈ 1.5 | ≈ 1.6 | $\approx 1.6^{\text{ocf}}$ | | | |
| 96-02992 ¹ | 127:2 | DL | < 1.09 | < 0.544 | $< 0.817^{\text{ocf}}$ | | | |

Table A-42. Tank 241-BX-104 Analytical Results: Zirconium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: fusion | | | | | | | | |
| 96-02979 | 126:1 | Whole | ≈ 484 | ≈ 367 | ≈ 426 ^{cc} | < 646 | N/A | < 380 |
| 96-02981 | 126:2 | Upper 1/2 | < 35.9 | < 84.9 | < 60.4 | | | |
| 96-02980 | | Lower 1/2 | < 60.6 | < 56.1 | < 58.4 | | | |
| 96-02982 | | | < 53.1 | < 74.6 | < 63.9 | | | |
| 96-02983 | 127:1 | Upper 1/2 | 1,733 | 930 | 1,330 ^{cc} | | | |
| 96-02984 | | Lower 1/2 | 842 | 695 | 769 | | | |
| 96-02985 ¹ | 127:2 | Whole | ≈ 202 | ≈ 194 | ≈ 198 | | | |
| 96-02986 ¹ | | | ≈ 214 | ≈ 190 | ≈ 202 | | | |
| Liquids: acid digest | | | | | | | | |
| 96-02989 | 126:1 | DL | < 1.30 | < 1.30 | < 1.30 | < 1.63 | N/A | < 0.0562 |
| 96-02990 | 126:2 | DL | < 2.60 | < 1.30 | < 1.95 | | | |
| 96-02992 ¹ | 127:2 | DL | < 2.72 | < 1.36 | < 2.04 | | | |

Table A-43. Tank 241-BX-104 Analytical Results: Chloride.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 890 | 870 | 880 | 1,040 | 17.7 | 613 |
| 96-2981 | 126:2 | Upper 1/2 | 790 | 740 | 765 ^{cc:t} | | | |
| 96-2982 | | Lower 1/2 | 910 | 890 | 900 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 1,320 | 1,260 | 1,290 | | | |
| 96-2984 | | Lower 1/2 | 1,130 | 1,140 | 1,140 | | | |
| 96-2985 ¹ | 127:2 | Whole | 580 | 610 | 595 ^{cc:t} | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 2,700 | 2,700 | 2,700 | 2,800 | 3.6 | 96.6 |
| 96-2990 | 126:2 | DL | 2,900 | 2,900 | 2,900 | | | |
| 96-2992 ¹ | 127:2 | DL | 1,400 | 1,400 | 1,400 | | | |

Table A-44. Tank 241-BX-104 Analytical Results: Fluoride.

| Sample Number | Core: Segment | Sub-segment | Result µB/g | Duplicate µB/g | Sample Mean µB/g | Overall Mean µB/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 600 | 600 | 600 ^{SC,d} | < 882 | N/A | < 519 |
| 96-2981 | 126:2 | Upper 1/2 | < 500 | < 500 | < 500 | | | |
| 96-2982 | | Lower 1/2 | < 500 | 600 | 550 | | | |
| 96-2983 | 127:1 | Upper 1/2 | < 500 | < 500 | < 500 | | | |
| 96-2984 | | Lower 1/2 | 2,000 | 1,800 | 1,900 | | | |
| 96-2985 ¹ | 127:2 | Whole | < 500 | < 500 | < 500 | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 300 | 300 | 300 | 300 | 0.0 | 10.4 |
| 96-2990 | 126:2 | DL | 300 | 300 | 300 | | | |
| 96-2992 ¹ | 127:2 | DL | 300 | 300 | 300 | | | |

Table A-45. Tank 241-BX-104 Analytical Results: Nitrate.

| Sample Number | Core Segment | Sub-segment | Result #g/g | Duplicate #g/g | Sample Mean #g/g | Overall Mean #g/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|--------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 34,000 | 35,000 | 34,500 | 47,800 | 22.4 | 28,200 |
| 96-2981 | 126:2 | Upper 1/2 | 35,900 | 33,200 | 34,600 | | | |
| 96-2982 | | Lower 1/2 | 43,000 | 43,000 | 43,000 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 66,000 | 66,000 | 66,000 | | | |
| 96-2984 | | Lower 1/2 | 52,000 | 51,400 | 51,700 | | | |
| 96-2985 ¹ | 127:2 | Whole | 26,300 | 26,300 | 26,300 | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 1.18E+05 | 1.18E+05 | 1.18E+05 | 1.35E+05 | 12.3 | 4,660 |
| 96-2990 | 126:2 | DL | 1.50E+05 | 1.52E+05 | 1.51E+05 | | | |
| 96-2992 ¹ | 127:2 | DL | 66,000 | 67,000 | 66,500 | | | |

Table A-46. Tank 241-BX-104 Analytical Results: Nitrite.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 18,000 | 18,000 | 18,000 | 24,200 | 28.5 | 14,300 |
| 96-2981 | 126:2 | Upper 1/2 | 16,300 | 15,000 | 15,700 | | | |
| 96-2982 | | Lower 1/2 | 18,000 | 18,000 | 18,000 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 35,200 | 35,000 | 35,100 | | | |
| 96-2984 | | Lower 1/2 | 27,000 | 26,300 | 26,700 | | | |
| 96-2985 ¹ | 127:2 | Whole | 11,400 | 11,400 | 11,400 | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 60,000 | 60,000 | 60,000 | 63,800 | 5.9 | 2,200 |
| 96-2990 | 126:2 | DL | 67,000 | 68,000 | 67,500 | | | |
| 96-2992 ¹ | 127:2 | DL | 29,700 | 29,700 | 29,700 | | | |

Table A-47. Tank 241-BX-104 Analytical Results: Phosphate.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 5,800 | 6,200 | 6,000 | 8,490 | 54.9 | 5,000 |
| 96-2981 | 126:2 | Upper 1/2 | 1,370 | 1,160 | 1,270 | | | |
| 96-2982 | | Lower 1/2 | 2,100 | 7,000 | 4,550 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 4,300 | 4,400 | 4,350 | | | |
| 96-2984 | | Lower 1/2 | 21,000 | 20,300 | 20,700 | | | |
| 96-2985 ¹ | 127:2 | Whole | 2,630 | 3,000 | 2,815 | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 4,900 | 5,000 | 4,950 | 4,780 | 3.7 | 165 |
| 96-2990 | 126:2 | DL | 4,600 | 4,600 | 4,600 | | | |
| 96-2992 ¹ | 127:2 | DL | 3,300 | 3,300 | 3,300 | | | |

Table A-48. Tank 241-BX-104 Analytical Results: Sulfate.

| Sample Number | Cort: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g | Overall Mean µg/g | RSD (Mean) % | Projected Inventory kg |
|------------------------------|---------------|-------------|----------------|-------------------|----------------------|----------------------|-----------------|---------------------------|
| Solids: water digest | | | | | | | | |
| 96-2979 | 126:1 | Whole | 1,400 | 1,400 | 1,400 ^{ccr} | 1,750 | 21.2 | 1,030 |
| 96-2981 | 126:2 | Upper 1/2 | 1,250 | 1,160 | 1,210 ^{ccr} | | | |
| 96-2982 | | Lower 1/2 | 1,500 | 1,500 | 1,500 ^{ccr} | | | |
| 96-2983 | 127:1 | Upper 1/2 | 2,360 | 2,350 | 2,360 | | | |
| 96-2984 | | Lower 1/2 | 2,000 | 1,700 | 1,850 ^{ccr} | | | |
| 96-2985 ¹ | 127:2 | Whole | 930 | 930 | 930 ^{ccr} | | | |
| Liquids: water digest | | | | | | | | |
| 96-2989 | 126:1 | DL | 3,700 | 3,800 | 3,750 | 3,930 | 4.5 | 136 |
| 96-2990 | 126:2 | DL | 4,100 | 4,100 | 4,100 | | | |
| 96-2992 ¹ | 127:2 | DL | 1,800 | 1,800 | 1,800 | | | |

Table A-49. Tank 241-BX-104 Analytical Results: Total Alpha.

| Sample Number | Core: Segment | Sub-segment | Result $\mu\text{Ci/g}$ | Duplicate $\mu\text{Ci/g}$ | Sample Mean $\mu\text{Ci/g}$ | Overall Mean $\mu\text{Ci/g}$ | RSD (Mean) % | Projected Inventory CI |
|----------------------|---------------|-------------|-------------------------|----------------------------|------------------------------|-------------------------------|--------------|------------------------|
| Solids | | | | | | | | |
| 96-2979 | 126:1 | Whole | 0.547 | 0.612 | 0.580 | 1.28 | 71.8 | 754 |
| 96-2982 | 126:2 | Lower 1/2 | 0.153 | 0.164 | 0.159 ^{cc:r} | | | |
| 96-2984 | 127:1 | Lower 1/2 | 2.13 | 2.24 | 2.19 | | | |
| 96-2985 ¹ | 127:2 | Whole | 0.374 | 0.358 | 0.366 | | | |
| Liquids | | | | | | | | |
| 96-2989 | 126:1 | DL | 3.89E-04 | 4.43E-04 | 4.16E-04 ^{cc:s} | 2.63e-04 | 58.2 | 0.0117 |
| 96-2990 | 126:2 | DL | < 1.2E-04 | < 1.0E-04 | < 1.1E-04 ^{cc:s} | | | |
| 96-2992 ¹ | 127:2 | DL | < 2.2E-04 | < 2.7E-04 | < 2.45E-04 | | | |

Table A-50. Tank 241-BX-104 Analytical Results: Cesium-137.

| Sample Number | Core: Segment | Sub-segment | Result $\mu\text{Ci/g}$ | Duplicate $\mu\text{Ci/g}$ | Sample Mean $\mu\text{Ci/g}$ | Overall Mean $\mu\text{Ci/g}$ | RSD (Mean) % | Projected Inventory CI |
|-----------------------|---------------|-------------|-------------------------|----------------------------|------------------------------|-------------------------------|--------------|------------------------|
| Solids: fusion | | | | | | | | |
| 96-2981 | 126:2 | Upper 1/2 | 64.7 | 76.0 | 70.4 | 73.1 | 3.7 | 43,100 |
| 96-2982 | | Lower 1/2 | 73.5 | 77.9 | 75.7 | | | |
| 96-2985 ¹ | 127:2 | Whole | 44.9 | 47.1 | 46.0 | | | |
| 96-2985 ¹ | | Whole | 46.8 | 51.5 | 49.2 | | | |

Table A-51. Tank 241-BX-104 Analytical Results: Weight Loss Percent Water.

| Sample Number | Core: Segment | Sub-segment | Result | | Duplicate | | Sample Mean | Overall Mean | RSD (Mean) |
|----------------------|---------------|-------------|--------------------|------------------------|--------------------|------------------------|--------------------|--------------|------------|
| | | | % H ₂ O | Temperature Range (°C) | % H ₂ O | Temperature Range (°C) | | | |
| Solids | | | | | | | | | |
| 96-2979 | 126:1 | Whole | 11.8 | 20-100 | 8.1 | 20-100 | 9.95 ^{CC} | 29.5 | 51.7 |
| 96-2981 | 126:2 | Upper 1/2 | 11.8 | 20-130 | 11.2 | 20-130 | 11.5 | | |
| 96-2982 | | Lower 1/2 | 23.5 | 20-170 | 20.8 | 20-170 | 22.2 | | |
| 96-2983 | 127:1 | Upper 1/2 | 49.5 | 20-160 | 46.5 | 20-160 | 48.0 | | |
| 96-2984 | | Lower 1/2 | 44.1 | 20-150 | 41.8 | 20-150 | 43.0 | | |
| 96-2985 ¹ | 127:2 | Whole | 24.0 | 20-180 | 22.9 | 20-180 | 23.5 | | |
| Liquids | | | | | | | | | |
| 96-2989 | 126:1 | DL | 58.4 | 20-100 | 58.4 | 20-100 | 58.4 | 59.1 | 1.1 |
| 96-2990 | 126:2 | DL | 60.4 | 20-100 | 59.0 | 20-100 | 59.7 | | |
| 96-2992 ¹ | 127:2 | DL | 78.3 | 20-110 | 77.1 | 20-110 | 77.7 | | |

Table A-52. Tank 241-BX-104 Analytical Results: Energetics.

| Sample Number | Core: Segment | Sub-segment | Run | Transition 1 | | | Transition 2 | | | Transition 3 | | |
|----------------------|---------------|-------------|-----|---------------------|--------------------|---------------------|--------------------|---------------------|--------------------|-----------------------|--------------------|---------------------|
| | | | | Sample Weight mg | Peak Temp. (°C) | ΔH (J/g) | Peak Temp. (°C) | ΔH (J/g) | Peak Temp. (°C) | ΔH (J/g) | Peak Temp. (°C) | ΔH (J/g) |
| Solids | | | | | | | | | | | | |
| 96-2979 | 126:1 | Whole | 1 | 20.243 | 80 | 132.2 | 130 | 225.2 | 290 | 407.9 | | |
| | | | 2 | 20.616 | 70 | 91.5 | 130 | 228.7 | 290 | 449.0 | | |
| 96-2981 | 126:2 | Upper 1/2 | 1 | 16.818 | --- | --- | 300 | 588.0 | --- | --- | | |
| | | | 2 | 25.096 | 80 | 231.5 | 290 | 688.5 | --- | --- | | |
| 96-2982 | | Lower 1/2 | 1 | 18.344 | 70 | 412.1 | 280 | 458.0 | --- | --- | | |
| | | | 2 | 23.387 | 80 | 347.4 | 280 | 449.6 | --- | --- | | |
| 96-2983 | 127:1 | Upper 1/2 | 1 | 11.229 | 70 | 935.3 | 280 | 37.4 | 350 | -17.5 | | |
| | | | 2 | 11.080 | 80 | 764.4 | 280 | 42.4 | 350 | -19.1 | | |
| 96-2984 | | Lower 1/2 | 1 | 9.143 | 70 | 589.5 | 280 | 129.9 | 370 | -5.6 | | |
| | | | 2 | 10.679 | 100 | 645.7 | 300 | 115.2 | 370 | -5.0 | | |
| 96-2985 ¹ | 127:2 | Whole | 1 | 15.534 | --- | --- | 300 | 553.4 | --- | --- | | |
| | | | 2 | 25.155 | 70 | 418.2 | 300 | 511.6 | --- | --- | | |
| Liquids | | | | | | | | | | | | |
| 96-2989 | 126:1 | DL | 1 | 20.910 | 90 | 884.2 | 150 | 61.9 | 280 | -30.8 | | |
| | | | 2 | 20.545 | 80 | 1,021.6 | 150 | 59.9 | 260 | -25.9 | | |
| 96-2990 | 126:2 | DL | 1 | 11.858 | 80 | 1,029.1 | 150 | 29.6 | 260 | -21.6 | | |
| | | | 2 | 12.883 | 80 | 1110.8 | 160 | 32.5 | 260 | -21.9 | | |
| 96-2992 ¹ | 127:2 | DL | 1 | 15.935 | 80 | 1,405.4 | 160 | 34.2 | 220 | -7.7 ^{9C*} | | |
| | | | 2 | 16.641 | 80 | 1,274 | 150 | 29.0 | 220 | -16.2 ^{9C**} | | |

Table A-53. Tank 241-BX-104 Analytical Results: Density.

| Sample Number | Core: Segment | Sub-segment | Result g/mL | Duplicate g/mL | Sample Mean g/mL | Overall Mean g/mL | RSD (Mean) % |
|-----------------------|---------------|-------------|----------------|-------------------|---------------------|----------------------|-----------------|
| Solids | | | | | | | |
| 96-02979 | 126:1 | Whole | 1.90 | 1.85 | 1.88 | 1.73 | 11.8 |
| 96-02981 | 126:2 | Upper 1/2 | 1.90 | 1.91 | 1.91 | | |
| 96-02982 | | Lower 1/2 | 2.02 | 2.00 | 2.01 | | |
| 96-02983 | 127:1 | Upper 1/2 | 1.43 | 1.43 | 1.43 | | |
| 96-02984 | | Lower 1/2 | 1.62 | 1.61 | 1.63 | | |
| 96-02985 ¹ | 127:2 | Whole | 1.86 | 1.81 | 1.84 | | |
| Liquids | | | | | | | |
| 96-02989 | 126:1 | DL | 1.28 | 1.27 | 1.28 | 1.29 | 0.4 |
| 92-02990 | 126:2 | DL | 1.27 | 1.3 | 1.29 | | |
| 96-02992 ¹ | 127:2 | DL | 1.15 | 1.15 | 1.15 | | |

Table A-54. Tank 241-BX-104 Analytical Results: TOC.

| Sample Number | Core Segment | Sub-segment | Result µg C/g | Duplicate µg C/g | Sample Mean µg C/g | Overall Mean µg C/g | RSD (Mean) % | Projected Inventory kg C |
|----------------------|--------------|-------------|------------------|---------------------|-----------------------|------------------------|-----------------|-----------------------------|
| Solids | | | | | | | | |
| 96-2979 | 126:1 | Whole | 7,070 | 6,490 | 6,780 | 5,210 | 42.1 | 3,070 |
| 96-2981 | 126:2 | Upper 1/2 | 1,100 | 1,040 | 1,070 | | | |
| 96-2982 | | Lower 1/2 | 600 | 680 | 640 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 7,440 | 8,680 | 8,060 | | | |
| 96-2984 | | Lower 1/2 | 5,380 | 4,890 | 5,140 | | | |
| 96-2985 ¹ | 127:2 | Whole | 2,300 | 2,600 | 2,450 | | | |
| Liquids | | | | | | | | |
| 96-2989 | 126:1 | DL | 4,100 | 4,270 | 4,190 | 3,190 | 31.3 | 110 |
| 96-2990 | 126:2 | DL | 2,130 | 2,250 | 2,190 | | | |
| 96-2992 ¹ | 127:2 | DL | 1,450 | 1,300 | 1,375 | | | |

Table A-55. Tank 241-BX-104 Analytical Results: TIC.

| Sample Number | Court Segment | Sub-segment | Result µg C/g | Duplicate µg C/g | Sample Mean µg C/g | Overall Mean µg C/g | RSD (Mean) % | Projected Inventory kg C |
|----------------------|---------------|-------------|------------------|---------------------|-----------------------|------------------------|-----------------|-----------------------------|
| Solids | | | | | | | | |
| 96-2979 | 126:1 | Whole | 3,580 | 3,770 | 3,680 | 4,830 | 35.4 | 2,840 |
| 96-2981 | 126:2 | Upper 1/2 | 2,720 | 2,700 | 2,710 | | | |
| 96-2982 | | Lower 1/2 | 3,080 | 2,680 | 2,880 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 7,760 | 8,350 | 8,060 | | | |
| 96-2984 | | Lower 1/2 | 4,510 | 5,040 | 4,780 | | | |
| 96-2985 ¹ | 127:2 | Whole | 2,020 | 2,160 | 2,090 | | | |
| Liquids | | | | | | | | |
| 96-2989 | 126:1 | DL | 9,930 | 10,300 | 10,100 | 8,950 | 12.9 | 309 |
| 96-2990 | 126:2 | DL | 7,740 | 7,860 | 7,800 | | | |
| 96-2992 ¹ | 127:2 | DL | 3,530 | 3,650 | 3,590 | | | |

Table A-56. Tank 241-BX-104 Analytical Results: TC.

| Sample Number | Core: Segment | Sub-segment | Result µg C/g | Duplicate µg C/g | Sample Mean µg C/g | Overall Mean µg C/g | RSD (Mean) % | Projected Inventory kg C |
|----------------------|---------------|-------------|------------------|---------------------|-----------------------|------------------------|-----------------|-----------------------------|
| | | | | | | | | |
| 96-2979 | 126:1 | Whole | 10,700 | 10,300 | 10,500 | 10,000 | 33.2 | 5,890 |
| 96-2981 | 126:2 | Upper 1/2 | 3,820 | 3,740 | 3,780 | | | |
| 96-2982 | | Lower 1/2 | 3,680 | 3,360 | 3,520 | | | |
| 96-2983 | 127:1 | Upper 1/2 | 15,200 | 17,000 | 16,100 | | | |
| 96-2984 | | Lower 1/2 | 9,890 | 9,930 | 9,910 | | | |
| 96-2985 ¹ | 127:2 | Whole | 4,320 | 4,760 | 4,540 | | | |
| Liquids | | | | | | | | |
| 96-2989 | 126:1 | DL | 14,000 | 14,600 | 14,300 | 12,100 | 17.8 | 417 |
| 96-2990 | 126:2 | DL | 9,870 | 10,100 | 9,990 | | | |
| 96-2992 ¹ | 127:2 | DL | 4,980 | 4,950 | 4,970 | | | |

APPENDIX B

**ANALYTICAL RESULTS OF HYDROSTATIC HEAD FLUID
CONTAMINATION CHECK FOR TANK 241-BX-104**

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B.0 ANALYTICAL RESULTS OF HYDROSTATIC HEAD FLUID CONTAMINATION CHECK FOR TANK 241-BX-104

B.1 INTRODUCTION AND ANALYTE TABLE DESCRIPTION

Appendix B reports the results of the HHF contamination check for the 1996 push mode core sampling and analysis event. Lithium and bromide were measured to detect any contamination of the waste samples by the HHF.

The data table for each of the two analytes lists the laboratory sample identification number in column one. Sampling rationale, locations, and a description of the sampling event are discussed in Section 3.0, and a more detailed description of the HHF results is presented in Section 4-1.4.

Column two specifies the core and segment from which each sample was derived.

Column three specifies the subsegment or whole segment for which the analyte was measured.

The Result and Duplicate columns are self-explanatory. The "Sample Mean" column is the average of the result and duplicate values. All values, including those below the detection level (indicated by the less-than symbol, <) and those that were estimated (indicated by the estimated symbol, ≈) were averaged in calculating the sample means. The estimated values are those that were recorded above the instrument detection limit, but were less than 10 times the estimated quantitation limit. All pairs of result and duplicate values for a given sample were both either nondetected, estimated, or detected. Thus, the sample means are expressed as a nondetected, estimated, or detected value. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded up in some cases and rounded down in others. This is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

The four quality control parameters assessed on the tank 241-BX-104 HHF samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. None of the lithium or bromide results violated any of the QC criteria specified in Kuhl-Klinger (1995).

Table B-1. Tank 241-BX-104 Analytical Results: Lithium.

| Sample Number | Core: Segment | Sub-segment | Result µg/g | Duplicate µg/g | Sample Mean µg/g |
|-----------------------------|---------------|-------------|----------------|-------------------|---------------------|
| Solids: fuston | | | | | |
| 96-02979 | 126:1 | Whole | < 110 | < 81.3 | < 95.7 |
| 96-02981 | 126:2 | Upper 1/2 | < 43.0 | < 102 | < 72.5 |
| 96-02980 | | Lower 1/2 | < 72.7 | < 67.3 | < 70.0 |
| 96-02982 | | | < 63.7 | < 89.5 | < 76.6 |
| 96-02983 | 127:1 | Upper 1/2 | < 80.3 | < 64.9 | < 72.6 |
| 96-02984 | | Lower 1/2 | < 79.0 | < 82.1 | < 80.6 |
| 96-02985 ¹ | 127:2 | Whole | ≈ 329 | ≈ 360 | ≈ 345 |
| 96-02986 ¹ | | | ≈ 337 | ≈ 379 | ≈ 358 |
| Liquids: acid digest | | | µg/mL | µg/mL | µg/mL |
| 96-02989 | 126:1 | DL | ≈ 0.8 | ≈ 1.1 | ≈ 0.95 |
| 96-02990 | 126:2 | DL | 36.7 | 37.2 | 37.0 |
| 96-02992 ¹ | 127:2 | DL | 838.4 | 841.9 | 840.2 |

Table B-2. Tank 241-BX-104 Analytical Results: Bromide.

| Sample Number | Core: Segment | Sub-segment | Result | Duplicate | Sample Mean |
|-----------------------|---------------|-------------|--------|-----------|-------------|
| Solids: water digest | | | µg/g | µg/g | µg/g |
| 96-2979 | 126:1 | Whole | < 500 | < 500 | < 500 |
| 96-2981 | 126:2 | Upper 1/2 | < 500 | < 500 | < 500 |
| 96-2982 | | Lower 1/2 | < 500 | < 500 | < 500 |
| 96-2983 | 127:1 | Upper 1/2 | < 500 | < 500 | < 500 |
| 96-2984 | | Lower 1/2 | < 500 | < 500 | < 500 |
| 96-2985 | 127:2 | Whole | 3,000 | 3,100 | 3,050 |
| Liquids: water digest | | | µg/mL | µg/mL | µg/mL |
| 96-2989 | 126:1 | DL | < 250 | < 250 | < 250 |
| 96-2990 | 126:2 | DL | < 250 | < 250 | < 250 |
| 96-2992 | 127:2 | DL | 14,000 | 14,000 | 14,000 |

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APPENDIX C

ANALYTICAL RESULTS FROM HISTORICAL SAMPLING EVENTS

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C.0 ANALYTICAL RESULTS FROM HISTORICAL SAMPLING EVENTS

C.1 INTRODUCTION

Appendix C presents analytical results from the historical sampling events of tank 241-BX-104. Because of the active process history of the tank, only the results from the 1986 core sampling event (presented in Table C-1) have been deemed representative of the current tank contents. Data from the remaining sampling events have been included in this appendix for informational purposes only. A description of the historical sampling events was provided in Section 3.4. Further detail regarding each sampling event can be found in the respective source document, which is listed in the footnotes to each table.

Table C-1. 1986 Core Sampling Analytical Results.^{1,2,3} (2 sheets)

| Analyte | Riser 1 Core Composite | Riser 8 Core Composite | Overall Mean |
|---------------|------------------------|------------------------|--------------|
| METALS | µg/g | µg/g | µg/g |
| Aluminum | 40,800 | 54,000 | 47,400 |
| Barium | 1,210 | 2,090 | 1,650 |
| Bismuth | 1,710 | 1,100 | 1,410 |
| Boron | 93,600 | 5.65 ² | --- |
| Cadmium | < 24.3 | < 25.0 | < 24.7 |
| Calcium | 3,880 | 5,800 | 4,840 |
| Chromium | 3,090 | 4,480 | 3,790 |
| Cobalt | 15.1 | 8.41 | 11.8 |
| Copper | 119 | 71.7 | 95.4 |
| Iron | 9,620 | 5,060 | 7,340 |
| Lead | 550 | 594 | 572 |
| Magnesium | 1,900 | 3,040 | 2,470 |
| Manganese | 831 | 1,130 | 981 |
| Nickel | 195 | 115 | 155 |
| Phosphorus | 4,500 | 3,010 | 3,760 |
| Potassium | 955 | 1,160 | 1,060 |
| Silicon | 25,900 | 38,900 | 32,400 |
| Silver | 108 | 70.8 | 89.4 |
| Sodium | 69,800 | 67,500 | 68,700 |
| Strontium | 77.1 | 46.6 | 61.9 |
| Uranium | 34,800 | 14,000 | 24,400 |
| Zinc | 121 | 102 | 112 |
| Zirconium | 1,140 | 1,370 | 1,260 |
| ANIONS | µg/g | µg/g | µg/g |
| Nitrate | 41,900 | 35,000 | 38,500 |

Table C-1. 1986 Core Sampling Analytical Results.^{1,2,3} (2 sheets)

| Analyte | Riser 1 Core Composite | Riser 8 Core Composite | Overall Mean |
|----------------------------|---|--|-------------------|
| RADIONUCLIDES | $\mu\text{Ci/g}$ | $\mu\text{Ci/g}$ | $\mu\text{Ci/g}$ |
| ²⁴¹ Am | < 0.227 | 1.03 | 0.629 |
| ¹⁴ C | 6.28E-04 | < 3.53E-04 | 4.91E-04 |
| ⁶⁰ Co | 0.0770 | 0.0600 | 0.0685 |
| ¹³⁷ Cs | 75.1 | 124 | 99.6 |
| ¹²⁹ I | 5.20E-05 | 3.50E-05 | 4.35E-05 |
| ^{239/240} Pu | 0.341 | 0.391 | 0.366 |
| ⁹⁰ Sr | 375 | 154 | 265 |
| ⁹⁹ Tc | 0.0335 | 0.0323 | 0.0329 |
| CARBON | $\mu\text{g C/g}$ | $\mu\text{g C/g}$ | $\mu\text{g C/g}$ |
| TOC | 1,780 | 2,710 | 2,250 |
| PHYSICAL PROPERTIES | | | |
| Bulk Density | 1.85 | 1.76 | 1.81 |
| pH | 11.0 | 11.0 | 11.0 |
| Particle Size | 10 μm mean population; 14.2 μm at 50% of total by volume | 30.9 μm mean population; 116.7 μm at 50% of total by volume | --- |

Notes:

¹Weiss and Schull (1988)²No value was reported for the fusion/acid digestion sample, drastically affecting the core mean. Because of this omission, an overall mean would not be valid.³Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-2. Supernatant Sample from Tank 241-BX-104 (T-2045).^{1,2}

| February 28, 1974 | | |
|-------------------------------|-------------------------------|-----------|
| Component | Lab Value | Lab Unit |
| Physical Data | | |
| Vis - OTR | yellow, no solids 200 mrad/hr | |
| pH | 11.01 | --- |
| SpG | 1.1325 | --- |
| H ₂ O | 89.03 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 5° C | 60 min | No solids |
| 10° C | 45 min | No solids |
| Chemical Analysis | | |
| Na | 1.64 | M |
| SO ₄ | 0.175 | M |
| Al | 2.57E-03 | M |
| NO ₂ | 0.754 | M |
| F | 5.82E-03 | M |
| CO ₃ | 0.334 | M |
| NO ₃ | 0.206 | M |
| PO ₄ | 1.47E-02 | M |
| OH | 0.384 | M |
| Radiological Analysis | | |
| Pu | 1.33E-04 | g/L |
| GEA: ¹³⁴ Cs | 83.64 | μCi/L |
| GEA: ¹³⁷ Cs | 1.63E+04 | μCi/L |
| GEA: ¹⁰⁶ RuRh | 4.82E+04 | μCi/L |

Notes:

¹Sant (1974)²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-3. Supernatant Sample from Tank 241-BX-104 (T-9245).^{1,2}

Taken: January, 10, 1975 Received: October 29, 1974

| Component | Lab Value | Lab Unit |
|-------------------------------|-------------------------------|-----------|
| Physical Data | | |
| Vis -OTR | Yellow, no solids, 1.7 rad/hr | |
| pH | > 12.7 | --- |
| SpG | 1.121 | --- |
| H2O | 86.53 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 25° C | 45 min | No solids |
| 20° C | 60 min | No solids |
| 15° C | 45 min | No solids |
| 10° C | 45 min | No solids |
| 5° C | 45 min | No solids |
| Chemical Analysis | | |
| OH | 4.78E-02 | M |
| Al | 1.0E-02 | M |
| Na | 13.5 | M |
| NO ₂ | 0.843 | M |
| NO ₃ | 0.243 | M |
| SO ₄ | Canceled by R.L. Walser | --- |
| PO ₄ | 1.46E-02 | M |
| F | 5.20E-03 | M |
| CO ₃ | 0.588 | M |
| Radiological Analysis | | |
| Pu | 2.68E-04 | g/gal |
| GEA: ¹³⁴ Cs | 1.70E+03 | μCi/gal |
| GEA: ¹³⁷ Cs | 1.99E+05 | μCi/gal |
| GEA: ¹⁰⁶ Ru Rh | 1.61E+05 | μCi/gal |
| ^{89/90} Sr | 72.75 | μCi/gal |

Notes:

¹Wheeler (1975a)

²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-4. Supernatant Sample from Tank 241-BX-104 (T-365).^{1,2}

| Taken: May 20, 1975 Received: December 6, 1974 | | |
|--|-----------------------------|-----------|
| Component | Lab Value | Lab Unit |
| Physical Data | | |
| Vis - OTR | Yellow, no solids, 1 rad/hr | |
| pH | 12.8 | --- |
| SpG | 1.1286 | --- |
| H ₂ O | 85.95 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 20° C | 60 min | No solids |
| 15° C | 45 min | No solids |
| 10° C | 75 min | No solids |
| 5° C | 45 min | No solids |
| Chemical Analysis | | |
| OH | 0.718 | M |
| Al | 1.10E-02 | M |
| Na | 2.80 | M |
| NO ₂ | 0.757 | M |
| NO ₃ | 0.219 | M |
| SO ₄ | Sample Slurped | --- |
| PO ₄ | 3.07E-02 | M |
| F | 4.95E-03 | M |
| Co | 0.564 | M |
| Radiological Analysis | | |
| Pu | 2.66E-04 | g/gal |
| GEA: ¹³⁴ Cs | 1.70E+03 | μCi/gal |
| GEA: ¹³⁷ Cs | 1.98E+05 | μCi/gal |
| GEA: ¹⁰⁶ RuRh | 1.43E+05 | μCi/gal |

Notes:

¹Wheeler (1975b)²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-5. Supernatant Sample from Tank 241-BX-104 (T-6110).^{1,2}

Taken: October 21, 1975 Received: July 15, 1975

| Component | Lab Value | Lab Units |
|-------------------------------|-------------------------------------|-----------|
| Physical Data | | |
| Vis-OTR | Dark yellow, no solids, 400 mrad/hr | |
| pH | 12.2 | --- |
| SpG | 1.1471 | --- |
| H2O | 84.20 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 25° C | 45 min | No solids |
| 20° C | 60 min | No solids |
| 15° C | 45 min | No solids |
| 10° C | 45 min | No solids |
| 5° C | 45 min | No solids |
| Chemical Analysis | | |
| OH | 0.217 | M |
| Al | 7.27E-03 | M |
| Na | 2.81E+00 | M |
| NO ₂ | 1.02E+00 | M |
| NO ₃ | 5.92E-01 | M |
| PO ₄ | 1.55E-02 | M |
| Cl | 9.12E-03 | M |
| F | 3.18E-03 | M |
| CO ₃ | 5.98E-01 | M |
| Radiological Analysis | | |
| Pu | 5.05E-04 | g/gal |
| GEA: ¹⁰⁶ RuRh | 1.58E+05 | μCi/gal |
| GEA: ¹²⁵ Sb | 1.06E+03 | μCi/gal |
| GEA: ¹³⁴ Cs | 1.26E+03 | μCi/gal |
| GEA: ¹³⁷ Cs | 1.42E+05 | μCi/gal |
| ^{89/90} Sr | 7.44E+03 | μCi/gal |

Note:

¹Wheeler (1975c)²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-6. Supernatant Sample from Tank 241-BX-104 (T-7088).^{1,2}

Taken: October 21, 1975 Received: August 15, 1975

| Component | Lab Value | Lab Units |
|-------------------------------|--------------------------------------|-----------|
| Physical Data | | |
| Vis-OTR | Clear yellow, no solids, 250 mrad/hr | |
| pH | 10.3 | --- |
| SpG | 1.1285 | --- |
| H ₂ O | 83.22 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 35° C | 45 min | No solids |
| 30° C | 45 min | No solids |
| 25° C | 45 min | No solids |
| 20° C | 45 min | No solids |
| 15° C | 45 min | No solids |
| 10° C | 45 min | No solids |
| 5° C | 45 min | No solids |
| Chemical Analysis | | |
| OH | < 5E-03 | M |
| Al | 1.82 | M |
| Na | 2.99 | M |
| NO ₂ | 0.765 | M |
| NO ₃ | 0.504 | M |
| PO ₄ | 8.81E-03 | M |
| Cl | 1.13E-02 | M |
| F | 5.78E-03 | M |
| CO ₃ | 0.577 | M |
| Radiological Analysis | | |
| Pu | 6.43E-04 | g/gal |
| GEA: ¹⁰⁶ RuRh | 1.84E+05 | μCi/gal |
| GEA: ¹³⁴ Cs | 1.12E+03 | μCi/gal |
| GEA: ¹³⁷ Cs | 1.23E+05 | μCi/gal |
| ^{89/90} Sr | 1.55E+04 | μCi/gal |

Notes: ¹Wheeler (1975c)²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-7. Supernatant Sample from Tank 241-BX-104 (T-9511),^{1,2}

| Taken: February 12, 1976 Received: November 5, 1975 | | |
|---|--------------------------------|-----------|
| Components | Lab Value | Lab Units |
| Physical Data | | |
| Vis-OTR | Yellow, no solids, 180 mrad/hr | |
| pH | 11.8 | --- |
| SpG | 1.087 | --- |
| H ₂ O | 87.97 | % |
| Cooling Curve Analysis | | |
| Temperature | Time | Solids |
| 20° C | 35 min | No solids |
| 15° C | 35 min | No solids |
| 10° C | 35 min | No solids |
| 5° C | 35 min | No solids |
| Chemical Analysis | | |
| OH | <9.5E-03 | M |
| Al | 8.15E-04 | M |
| Na | 1.88 | M |
| NO ₂ | 0.708 | M |
| NO ₃ | 0.242 | M |
| PO ₄ | 9.28E-03 | M |
| Cl | 1.33E-02 | M |
| F | 6.00E-03 | M |
| CO ₃ | 0.548 | M |
| Radiological Analysis | | |
| Pu | 4.16E-04 | g/gal |
| GEA: ¹³⁴ Cs | 4.48E+02 | μCi/gal |
| GEA: ¹³⁷ Cs | 9.20E+04 | μCi/gal |
| GEA: ¹⁰⁶ RuRh | 1.44E+05 | μCi/gal |
| ^{89/90} Sr | 8.38E+03 | μCi/gal |

Notes:

¹Wheeler (1976)

²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

Table C-8. Hot Boildown of 104-BX Waste Liquor.^{1,2} (2 sheets)

| August 14, 1980 | | | |
|--------------------------------------|--------------------------------|---------------------------------|-----------------|
| WVR versus Pressure (Sample #T-1785) | | | |
| %WVR | Temperature (°C/°F) | | Pressure (Torr) |
| 0 | 34.4/93.9 | | 40 |
| | 42.0/107.6 | | 60 |
| | 47.6/117.8 | | 80 |
| 10 | 34.6/94.0 | | 40 |
| | 42.0/107.6 | | 60 |
| | 47.6/117.8 | | 80 |
| 20 | 34.6/94.0 | | 40 |
| | 42.0/107.6 | | 60 |
| 30 | 34.6/94.2 | | 40 |
| 40 | 34.6/94.2 | | 40 |
| 50 | 35.0/95.0 | | 40 |
| | 42.6/108.8 | | 60 |
| | 48.2/119.0 | | 80 |
| 60 | 35.6/96.0 | | 40 |
| | 43.2/109.6 | | 60 |
| | 49.0/120.0 | | 80 |
| 70 | 36.6/98.0 | | 40 |
| | 44.8/112.6 | | 60 |
| | 50.4/122.4 | | 80 |
| 75 | 37.8/100.0 | | 40 |
| | 45.4/114.0 | | 60 |
| | 51.6/125.2 | | 80 |
| Component | Lab Value T-1784 (one foot) | Lab Value T-1785 (four foot) | Lab Unit |
| Physical Data | | | |
| SpG | 1.1554 | 1.1572 | --- |
| H ₂ O | 82.330 | 81.82 | % |

Table C-8. Hot Boildown of 104-BX Waste Liquor.^{1,2} (2 sheets)

| August 14, 1980 | | | |
|--------------------------------------|----------|----------|-------|
| WVR versus Pressure (Sample #T-1785) | | | |
| Chemical Analysis | | | |
| Al | 0.268 | 0.291 | M |
| OH | 0.738 | 0.622 | M |
| NO ₂ | 0.594 | 0.603 | M |
| NO ₃ | 0.942 | 0.879 | M |
| CO ₃ | 0.110 | 0.120 | M |
| PO ₄ | 0.0346 | 0.0374 | M |
| TOC | NR | 4.060 | g/L |
| Radiological Analysis | | | |
| ¹³⁷ Cs | 2.01E+05 | 2.04E+05 | μCi/L |
| ^{89/90} Sr | 1.00E+04 | 1.20E+04 | μCi/L |

Notes:

¹Herting (1980)²Because of the lack of proper QC procedures, historical data may not be reliable and should be used with caution.

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