SRR-CWDA-2020-00029
Revision 1

Inventory Assignment at Closure for FDB-5 and FDB-6

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Prepared for U.S. Department of Energy Under Contract No. DE-AC09-09SR22505

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EXECUTIVE SUMMARY

This document outlines the approaches used to assign inventories at closure for F-Area Diversion Box (FDB)-5 and FDB-6 for use in F-Area Tank Farm (FTF) Performance Assessment (PA) modeling and other regulatory documents. The analytes used for the inventory determination are the same 60 radionuclides and 18 chemicals used for ancillary equipment inventory assignment in the FTF PA (SRS-REG-2007-00002). The methodology used to assign the FDB-5 and FDB-6 inventories is similar to the approach used in the FTF PA to determine the FTF piping systems residual inventory. Using this approach results in there being several conservatisms inherent in the final FDB-5 and FDB-6 inventories.

Camera inspection confirmed that the FDB-5 and FDB-6 vault and sump walls are clean with a minimal accumulation of material on the vault floor of only FDB-6, as would be expected in FDBs cleaned by flushing. To account for any uncertainty associated with volume determination through visual inspection, the radiological and chemical inventory assigned to FDB-5 and FDB-6 conservatively assumed a non-negligible accumulation of residue on the FDB surfaces (jumper internals and floors) most likely to have collected material after flushing (for example, the inventory associated with approximately 5.3 gallons of residual sludge slurry is assumed to remain on the FDB-6 floor).

As an additional conservatism, the calculated transfer line residue surface concentrations used in the inventory estimate assume sludge slurry as the starting material when the flushed material would be dried salt which would contain significantly less long-lived transuranic radionuclides of concern (the material would be dried salt not sludge because the transfers through FDB-5 and FDB-6 were of supernate (evaporator feed and concentrated supernate), not sludge slurry). This approach is consistent with the methodology utilized in the FTF PA for residue surface concentrations. [SRS-REG-2007-00002] In addition, the residue surface concentrations used in the FDB-5 and FDB-6 inventory assignment are decayed only to 9/30/2020, consistent with the FTF closure date assumed in the FTF PA. The date of FTF closure will in fact be much later with some of the radionuclides of interest (e.g., Cs-137, Sr-90) being overrepresented in the FDB-5 and FDB-6 inventory because additional decay between 2020 and the date of actual FTF closure is not accounted for. The conservative nature of the inventory approach used is confirmed by the fact that the assigned inventory for FDB-5 contained significantly more radioactivity than would be indicated by two surveys of FDB-5 performed in 2020.

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CRC	Cesium Removal Column
CTS	Concentrate Transfer System
DBs	Diversion Boxes
FDB	F-Area Diversion Box
FTF	F-Area Tank Farm
HTF	H-Area Tank Farm
LDBs	Leak Detection Boxes
PA	Performance Assessment
PTs	Pump Tanks
PPs	Pump Pits
SRR	Savannah River Remediation
SRS	Savannah River Site
WCS	Waste Characterization System

1.0 INTRODUCTION

The purpose of this document is to outline the approaches used to assign inventories at closure for F-Area Diversion Box (FDB)-5 (Figure 1.0-1) and FDB-6 (Figure 1.0-2) for use in F-Area Tank Farm (FTF) Performance Assessment (PA) modeling and other regulatory documents. The analytes used for the inventory determination were the same 60 radionuclides and 18 chemicals used for ancillary equipment inventory assignment in the FTF PA. [SRS-REG-2007-00002] This document begins with a general discussion of the FTF PA ancillary structures and inventory development approach used in the FTF PA before presenting the inventory approach and results for FDB-5 and FDB-6.

Figure 1.0-1: FDB-5

Figure 1.0-2: FDB-6

2.0 BACKGROUND

2.1 FTF Ancillary Structures

The FTF contains different types of ancillary structures with varying potential residual inventories that must be accounted for as part of facility closure. The FTF ancillary structures include buried pipe (transfer lines), pump tanks, and evaporators, all of which served as primary waste containment and have been in contact with liquid waste over the operating life of the facility. The amount of contamination on these components depends on factors such as service life of the component, materials of construction, and the contaminating medium in contact with the component.

The FTF PA (SRS-REG-2007-00002) evaluates the potential long-term radiological and chemical impact to receptors in support of various regulatory documents. The FTF PA models the release and transport of contaminants (radionuclides and chemicals) from the various FTF closure locations including waste tanks and ancillary structures (the FTF PA uses the terms ancillary structures and ancillary equipment interchangeably). The following FTF ancillary structures are explicitly addressed in the FTF PA waste modeling.

- The FTF transfer line system (approximately 45,000 linear feet of transfer lines), including transfer line jackets, Leak Detection Boxes (LDBs) and other transfer line secondary containment systems (e.g., the Type I tank transfer line encasements).
- The FTF pump tanks (PTs) (FPT-1/FPT-2/FPT-3), Pump Pits (PPs) (FPP-1/FPP-2/FPP-3) and Catch Tank.
- The 242-F Evaporator system, including the evaporator cell and support tanks (e.g., Mercury Collection Tank, Cesium Removal Column (CRC) Pump Tank, Concentrate Transfer System (CTS) pump tank, and overheads tanks).
- The 242-16F Evaporator system, including the evaporator cell and support tanks (e.g., Mercury Collection Tank, CRC Pump Tank, and overheads tanks).

The following approach is used in the FTF PA to explicitly model contaminant release:

- Transfer line inventory is modeled by distributing the assumed inventory uniformly throughout the FTF modeling cells.
- The pump tanks, Catch Tank, evaporator pots, and CTS pump tank are modeled as uniform inventories spread throughout a single modeling cell at the location of the applicable ancillary source.

Other FTF ancillary structures, such as Diversion Boxes (DBs), valve boxes, PPs, evaporator cells, and overheads tanks, are not modeled explicitly in the FTF PA. This PA modeling approach was based on the fact that these locations did not serve as typical primary waste containment, and therefore should not contain significant radiological inventory at closure relative to other modeled inventories. [SRS-REG-2007-00002]

2.2 FTF PA Ancillary Inventory General Approach

For some of the FTF ancillary structures (e.g., the 242-F Evaporator) field characterization data was available at the time the FTF PA was developed and this data was used to estimate the residual material inventories at closure. For most of the FTF ancillary structures, location specific field characterization data was not readily available, and the inventories are based on data from the Waste Characterization System (WCS) (the WCS tracks waste tank data, including projected radionuclide and chemical inventories, based on sample analyses, process histories, composition studies, and theoretical relationships). The FTF PA used the inventory of each FTF waste tank to establish a bounding characterization for the residual material concentration in ancillary structures without field characterization data, such as the transfer lines. [SRS-REG-2007-00002, LWO-PIT-2006-00069]

A review of the waste transfers within FTF and between FTF and H-Area Tank Farm (HTF) was performed and the results of this review was used to determine a representative waste concentration for transfer lines (determined by tank-specific transfer involvement and applying a weighted average to each contaminant in the individual FTF waste tanks). Each tank's dry sludge waste characterization was conservatively used in this determination (in practice tank sludge would have to be slurried to remove it from the waste tank and transfer through the ancillary structures). It is important to note that, while the sludge concentrations are used, dry sludge is only a small portion of the total waste that passes through the transfer lines that are routinely flushed with a high volume of supernate (which constitutes the majority of transfers). Using the dry sludge concentrations provides a conservative representation of the actinides and certain long-lived isotopes. The short-lived isotopes which are more concentrated in the supernate than the sludge will have decayed significantly during the 100-year active institutional control period and will not be significant dose contributors for the long-term impacts hundreds to thousands of years in the future. The weighted concentration of radionuclides and chemical constituents in the slurried sludge (decayed to September 30, 2020) is presented in Tables 2.2-1 and 2.2-2, respectively. [SRS-REG-2007-00002]

Table 2.2-1: Representative Radionuclide Concentrations of Sludge Slurry

Radionuclide	Concentration (Ci/gal)		Radionuclide	Concentration (Ci/gal)		Radionuclide	Concentration (Ci/gal)
Ac-227	3.18E-11		Eu-152	2.76E-04		Rh-106	6.16E-09
Al-26	3.10E-07		Eu-154	3.01E-03		Ru-106	6.16E-09
Am-241	2.43E-02		Eu-155	2.68E-03		Sb-125	1.70E-04
Am-242m	3.50E-05		H-3	3.39E-05		Sb-126	9.27E-06
Am-243	3.97E-06		I-129	2.95E-09		Sb-126m	6.61E-05
Ba-137m	2.27E-01		Na-22	4.87E-07		Se-79	3.53E-05
Bk-249	9.15E-32		Nb-94	1.57E-06		Sm-151	1.03E-01
C-14	1.77E-06		Ni-59	6.98E-05		Sn-126	6.61E-05
Ce-144	7.93E-11		Ni-63	5.78E-03		Sr-90	1.30E+00
Cf-249	3.36E-23		Np-237	3.28E-06		Tc-99	6.24E-04
Cm-242	1.00E-22		Pa-231	1.30E-09		Te-125m	4.16E-05
Cm-243	5.85E-07		Pm-147	2.59E-03		Th-229	2.09E-06
Cm-244	1.12E-03		Pr-144	7.93E-11		Th-230	5.95E-06
Cm-245	1.44E-08		Pu-238	7.63E-03		U-232	3.10E-08
Cm-247	5.36E-21		Pu-239	3.00E-03		U-233	1.55E-05
Cm-248	1.24E-21		Pu-240	1.10E-03		U-234	9.95E-06
Co-60	9.69E-04		Pu-241	5.18E-03		U-235	1.18E-07
Cs-134	5.38E-07		Pu-242	9.07E-06		U-236	1.90E-07
Cs-135	6.82E-07		Pu-244	4.27E-09		U-238	5.82E-06
Cs-137	2.43E-01		Ra-226	5.99E-06		Y-90	1.30E+00

[SRS-REG-2007-00002]

Table 2.2-2: Representative Chemical Concentrations of Sludge Slurry

Chemical	Concentration (kg/gal)		Chemical	Concentration (kg/gal)		Chemical	Concentration (kg/gal)
Ag	3.40E-04		F	3.07E-04		Pb	2.49E-03
As	1.15E-05		Fe	4.84E-02		Sb	2.74E-04
Ba	4.18E-04		Hg	3.24E-04		Se	3.53E-05
Cd	1.19E-03		Mn	8.75E-03		U	1.90E-02
Cr	4.46E-04		Ni	3.52E-02		Zn	4.24E-04
Cu	2.27E-04		NO_2 & NO_3	4.02E-02			

[SRS-REG-2007-00002]

2.3 FTF PA Transfer Line Inventory

The amount of residual material in the FTF transfer lines was determined analytically. Residual waste in the transfer lines can take three forms:

- Diffusion into the metal
- Residue in the oxide film
- Residue left behind after a transfer and flush

The FTF PA (Section 3.3) documents the surface concentrations (in curies or kilogram per square foot) for each of these three contributors based on a representative dry sludge waste. The total radiological and chemical inventory assigned to the transfer lines in the FTF PA was calculated based on these surface concentrations multiplied by the total affected surface area of the transfer lines in FTF (approximately 36,000 ft^2). The majority (i.e., greater than 99%) of the contribution for the transfer line inventory is from the residue after flushing. The transfer line core piping is flushed three times the line volume following transfers as normal operating procedure. By performance of a mass balance, the waste concentrations follow an exponential decay curve with respect to time. Tables 3.3-11 and 3.3-12 of the FTF PA present the remaining surface concentration in the transfer lines following three flush volumes. [SRS-REG-2007-00002]

2.4 FDB-5/FDB-6 Background and History

Diversion Boxes are reinforced concrete structures containing transfer line nozzles to which jumpers are connected to direct waste transfers to the desired location. Detailed descriptions of FDB-5 and FDB-6 are provided in Appendices D and E respectively of *Regulatory Strategy for Closure of F-Area and H-Area Tank Farms Ancillary Structures* (SRR-CWDA-2018-00064).

FDB-5 is a rectangular concrete structure 13 feet long, 11.25 feet wide, and 17.17 feet high (inside dimensions). [W702452] The structure has a 3-foot-long, 2-foot-wide, and 1.6-foot-deep stainless steel-lined sump in the northeast corner of the floor. The floor slopes towards a gutter along the east wall that drains to the sump. [W703321] There are two jumpers installed in FDB-5, with two abandoned jumpers on the floor (confirmed by video inspection). The FDB-5 total floor surface area (floor plus sump) is approximately 150 square feet (13 feet long by 11.25 feet wide). [SRR-CWDA-2018-00064, U-ESR-F-00092] The four FDB-5 jumpers contribute an additional 32 square feet of surface area (assuming 60.4 linear feet of 2-inch pipe). [W702452, SRR-CWDA-2018-00064] The total assigned inventory surface area for FDB-5 is 182 square feet.

FDB-5 was used to transfer waste between the 242-3F CTS, Tanks 25F through 28F, and Tanks 33F and 34F. The transfers through FDB-5 were of concentrated supernate and no "Fresh Canyon Waste" or "Sludge Slurry" transfers passed through FDB-5. FDB-5 was sprayed down to remove contamination during each entry and the stainless-steel lined walls and sumps minimized residual contamination levels. The diversion box and sump were not intended to be used as material primary containment locations, and waste in the box would drain to the sump via a sloped floor, then would passively drain by gravity to FPT-2. FDB-5 had a history of internal piping plugging caused by the concentrated high-salt CTS waste crystallizing in the transfer lines. When piping became plugged, the internal jumper was disconnected and lifted near the top of the vault. A "skill-of-the-craft catheterization procedure" was used to dissolve the salt and flush the line internals with clean water. The procedure involved inserting a polyethylene tube fed with water into the jumper and allowing the water to dissolve and flush out the very soluble salt waste. After the dissolution was complete, the interior walls of FDB-5 were washed down using the flushing apparatus. [SRR-CWDA-2018-00064] Camera inspection confirmed that the walls are clean with a minimal accumulation of material on the floor, as would be expected in FDBs cleaned by flushing with clean water. [U-ESR-F-00092]

FDB-6 is a rectangular concrete structure 15 feet long, 11 feet wide and 18 feet high (inside dimensions). [W702275] The structure has a 2-foot-wide by 3-foot-long and 1.2-foot-deep stainless steel-lined sump in the southwest corner of the floor. The floor slopes towards a gutter along the west wall that drains to the sump. [W703384] There are two jumpers installed in FDB-6, with two abandoned jumpers on the floor (confirmed by video inspection). The FDB-6 total floor surface area (floor plus sump) is approximately 170 square feet (15 feet long by 11 feet wide). [SRR-CWDA-2018-00064] The four FDB-6 jumpers contribute an additional 39 square feet of surface area (assuming 75 linear feet of 2-inch pipe). [W702275, SRR-CWDA-2018-00064] The total assigned inventory surface area for FDB-6 is 209 square feet.

FDB-6 was used to transfer feed material to the 242-F Evaporator from Tanks 26F and 7F. The transfers through FDB-6 were of supernate (evaporator feed) and no “Fresh Canyon Waste” or “Sludge Slurry” transfers passed through FDB-6. No significant waste leaks or spills inside the FDB-6 vault have been reported. In March 1979, after hydrotesting of the feed line from FDB-6 to the 242-1F Evaporator, contaminated water was found in the FDB-6 sump. The source appeared to be leakage from a dummy connector. Decontamination of FDB-6 reduced the transferable contamination. In December 1979, 10 inches of suspected rainwater (low in contamination) was drained from the FDB-6 sump. FDB-6 was inspected on July 13, 2018, August 31, 2019, and December 7, 2019. The floor appeared to be free of residual material. The one exception was below Nozzle 4, where a small deposit of light-colored material was present on the floor. The volume appears to be very small and may be related to a leak of the jumper or Nozzle 4 connector. [U-ESR-F-00092]

2.5 FDB-5 Radiological Survey

Two radiological surveys of FDB-5 were performed in early 2020. A smear (Survey #: TKFM-M-20200205-28) was obtained via a recently installed hole in the FDB-5 cell cover. The smear was sleeved out of the diversion box and a radiological protection field probe of the contained smear was 12 mrad/hr/cm^2 beta-gamma (5.0E-04 Ci/ft^2) [Equation 1]. Since the smear was visually wet, a decision was made to not open the sleeving to obtain an alpha reading as the reading would not be of a dry smear. A second smear (Survey #: TKFM-M-20200210-18) was obtained later, and the smear probed 60 dpm/cm^2 alpha (2.5E-08 Ci/ft^2) [Equation 2], 1.2 mrad/hr/cm^2 beta-gamma (5.0E-05 Ci/ft^2) [Equation 3].

> [Equation 1] - (12 mrad/hr/cm^2) * (929.03 cm^2 /ft^2) * (100,000 dpm/mrad/hr)[(a)] * (4.5E-13 Ci/dpm) = (5.0E-04 Ci/ft^2 beta-gamma)
>
> [Equation 2] - (60 dpm/cm^2) * (929.03 cm^2 /ft^2) * (4.5E-13 Ci/dpm) = (2.5E-08 Ci/ft^2 alpha)
>
> [Equation 3] - (1.2 mrad/hr/cm^2) * (929.03 cm^2 /ft^2) * (100,000 dpm/mrad/hr)[(a)] * (4.5E-13 Ci/dpm) = (5.0E-05 Ci/ft^2 beta-gamma)
>
> Note (a) - 100,000 dpm per detector area is roughly equivalent to a skin dose rate of 1 mrad/hr at contact (distance of 5 cm) [SRR-RPE-2012-00031]

3.0 INVENTORY ASSIGNMENT APPROACH FOR FDB-5 AND FDB-6

The approach used to assign inventories after closure for FDB-5 and FDB-6 is outlined below. Assumptions made regarding the residual quantities present in the various prioritized FTF ancillary structures have historically been based on process knowledge, including available characterization data and a review of applicable historical documentation/photographs/videos. [SRS-REG-2007-00002, SRR-CWDA-2018-00064] Inventories for the FDBs are not modeled explicitly in the FTF PA based on the fact that these locations did not serve as primary waste containment, and therefore were assumed to contain negligible inventories at closure. The FDB inventories are insignificant relative to other nearby inventory sources (e.g., transfer lines, waste tanks) that are explicitly modeled in the FTF PA.

As discussed in the FDB-5/FDB-6 Background and History section, there have historically been no significant leaks into FDB-5 or FDB-6, and any inventory after closure within these FDBs would be due to minor jumper/connector leakage and/or equipment flushing. The only residual contamination would be on the internal surfaces of the structure produced during jumper cleaning. Because the waste was highly-soluble salt, and the cell was washed after jumper cleaning, there should be only minimal residual material. Transfer lines are typically flushed several times with clean water after each transfer, so only minimal waste might be present inside those lines. Camera inspection confirmed that the walls are clean with a minimal accumulation of material on the floor, as would be expected in FDBs cleaned by flushing. [U-ESR-F-00092, U-ESR-F-00094] The structure and sump wall contribution to inventory is therefore assumed to be insignificant.

The components that would be most contaminated at closure are the floor surfaces (where residual material may have accumulated after FDB flushing with clean water) and the jumpers left in the FDBs. The floor surfaces would therefore be the most significant contributors to the FDB residual inventory at closure. Camera inspection confirmed that the FDB-5 and FDB-6 floors are visually clean, as would be expected based on the flushing and draining that occurred in the FDBs. The one exception is the FDB-6 floor, which has a small accumulation of what appears to be salt material under the area of Nozzle 4. The volume appears to be very small and may be related to a leak of the jumper or Nozzle 4 connector. The accumulation is nominally estimated to be 0.3 gallons of dried supernate (the low-end estimate is 0.1 gallons and the high-end estimate is 0.6 gallons). [U-ESR-F-00092, U-ESR-F-00094]

The FDB-5 and FDB-6 assigned inventory remaining at closure can be represented analytically using a similar approach as was used in the FTF PA to determine the residual material in the FTF piping systems. The residue on the FDB surfaces (jumpers and floors) can be reasonably bounded by assuming that residual accumulation in the FDBs is similar to the interior of transfer lines (which are based on based on representative dry sludge waste concentrations decayed to 9/30/20). While not directly analogous, this approach accounts for a residual remaining which would bound the insignificant amount of material evident on the FDB floors in the visual inspections performed. This approach would ignore inventory accumulation via diffusion into metal or oxide film since these mechanisms are insignificant (i.e., less than 1%) compared to the contribution associated with residual inventory after flushing. The bounding nature of this approach is supported given the FDB surfaces were flushed with clean water thus greatly reducing the concentration of the soluble constituents and leaving the insoluble constituents mostly unchanged.

4.0 INVENTORY AFTER CLOSURE FOR FDB-5 AND FDB-6

The analytes used for the FDB inventory determination are the same 60 radionuclides and 18 chemicals used for ancillary equipment inventory assignment in the FTF PA. The total chemical and radiological inventory assigned to FDB-5 (Tables 4.1-1 and 4.1-2) and FDB-6 (Tables 4.2-1 and 4.2-2) after closure can be determined by multiplying the previously calculated transfer line residue surface concentrations from Table 3.3-11 of the FTF PA (SRS-REG-2007-00002) by the total affected FDB-5 and FDB-6 surface areas [Equations 4 and 5]. The FTF PA 4-inch core pipe size concentration is the most conservative radiological surface concentration calculated (i.e., approximately thirty percent more Curies per square foot than the FTF PA 3-inch core pipe size concentration) and represents a reasonably bounding floor and jumper coating after flushing. The DB jumpers were all assumed to be 2-inch inner diameter (even though FDB-6 contains 3-inch core pipe) so using the 4-inch core pipe size concentration accounts for any jumper size variability within the DBs. Using the 4-inch core pipe size concentration assigns 0.031 gallons of sludge slurry per square foot of residual surface area (calculated by dividing the sludge slurry Curies per square foot for a 4-inch transfer line by the Curies per gallon for the corresponding concentration). It should be noted that these concentrations are based on representative dry sludge waste concentrations decayed only to September 30, 2020.

4.1 FDB-5 Inventory

[Equation 4] - (182 square feet of surface area) X (Specified RAD or CHEM in Ci/ft^2 or Kg/ft^2)

Table 4.1-1: FDB-5 Chemical Inventory

Chemical	4-inch (Kg/ft^2)	Kg
Ag	1.06E-05	1.93E-03
As	3.58E-07	6.52E-05
Ba	1.31E-05	2.38E-03
Cd	3.72E-05	6.77E-03
Cr	1.39E-05	2.53E-03
Cu	7.08E-06	1.29E-03
F	9.60E-06	1.75E-03
Fe	1.51E-03	2.75E-01
Hg	1.01E-05	1.84E-03
Mn	2.73E-04	4.97E-02
Ni	1.10E-03	2.00E-01
NO_2 & NO_3	1.26E-03	2.29E-01
Pb	7.77E-05	1.41E-02
Sb	8.56E-06	1.56E-03
Se	1.10E-06	2.00E-04
U	5.95E-04	1.08E-01
Zn	1.32E-05	2.40E-03

Table 4.1-2: FDB-5 Radiological Inventory

Radionuclide	4-inch (Ci/ft^2)	Curies	Radionuclide	4-inch (Ci/ft^2)	Curies
Ac-227	9.95E-13	1.81E-10	Pa-231	4.06E-11	7.39E-09
Al-26	9.69E-09	1.76E-06	Pm-147	8.11E-05	1.48E-02
Am-241	7.60E-04	1.38E-01	Pr-144	2.48E-12	4.51E-10
Am-242m	1.09E-06	1.98E-04	Pu-238	2.38E-04	4.33E-02
Am-243	1.24E-07	2.26E-05	Pu-239	9.36E-05	1.70E-02
Ba-137m	7.08E-03	1.29E+00	Pu-240	3.44E-05	6.26E-03
Bk-249	2.86E-33	5.21E-31	Pu-241	1.62E-04	2.95E-02
C-14	5.53E-08	1.01E-05	Pu-242	2.83E-07	5.15E-05
Ce-144	2.48E-12	4.51E-10	Pu-244	1.33E-10	2.42E-08
Cf-249	1.05E-24	1.91E-22	Ra-226	1.87E-07	3.40E-05
Cm-242	3.13E-24	5.70E-22	Rh-106	1.93E-10	3.51E-08
Cm-243	1.83E-08	3.33E-06	Ru-106	1.93E-10	3.51E-08
Cm-244	3.51E-05	6.39E-03	Sb-125	5.31E-06	9.66E-04
Cm-245	4.50E-10	8.19E-08	Sb-126	2.90E-07	5.28E-05
Cm-247	1.68E-22	3.06E-20	Sb-126m	2.07E-06	3.77E-04
Cm-248	3.87E-23	7.04E-21	Se-79	1.10E-06	2.00E-04
Co-60	3.03E-05	5.51E-03	Sm-151	3.21E-03	5.84E-01
Cs-134	1.68E-08	3.06E-06	Sn-126	2.07E-06	3.77E-04
Cs-135	2.13E-08	3.88E-06	Sr-90	4.07E-02	7.41E+00
Cs-137	7.60E-03	1.38E+00	Tc-99	1.95E-05	3.55E-03
Eu-152	8.61E-06	1.57E-03	Te-125m	1.30E-06	2.37E-04
Eu-154	9.39E-05	1.71E-02	Th-229	6.53E-08	1.19E-05
Eu-155	8.36E-05	1.52E-02	Th-230	1.86E-07	3.39E-05
H-3	1.06E-06	1.93E-04	U-232	9.67E-10	1.76E-07
I-129	9.23E-11	1.68E-08	U-233	4.84E-07	8.81E-05
Na-22	1.52E-08	2.77E-06	U-234	3.11E-07	5.66E-05
Nb-94	4.90E-08	8.92E-06	U-235	3.68E-09	6.70E-07
Ni-59	2.18E-06	3.97E-04	U-236	5.94E-09	1.08E-06
Ni-63	1.81E-04	3.29E-02	U-238	1.82E-07	3.31E-05
Np-237	1.03E-07	1.87E-05	Y-90	4.07E-02	7.41E+00

4.2 FDB-6 Inventory

[Equation 5] - (209 square feet of surface area) X (Specified RAD or CHEM in Ci/ft^2 or Kg/ft^2)

Table 4.2-1: FDB-6 Chemical Inventory

Chemical	4-inch (Kg/ft^2)	Kg
Ag	1.06E-05	2.22E-03
As	3.58E-07	7.48E-05
Ba	1.31E-05	2.74E-03
Cd	3.72E-05	7.77E-03
Cr	1.39E-05	2.91E-03
Cu	7.08E-06	1.48E-03
F	9.60E-06	2.01E-03
Fe	1.51E-03	3.16E-01
Hg	1.01E-05	2.11E-03
Mn	2.73E-04	5.71E-02
Ni	1.10E-03	2.30E-01
NO_2 & NO_3	1.26E-03	2.63E-01
Pb	7.77E-05	1.62E-02
Sb	8.56E-06	1.79E-03
Se	1.10E-06	2.30E-04
U	5.95E-04	1.24E-01
Zn	1.32E-05	2.76E-03

Table 4.2-2: FDB-6 Radiological Inventory

Radionuclide	4-inch (Ci/ ft^2)	Curies		Radionuclide	4-inch (Ci/ ft^2)	Curies
Ac-227	9.95E-13	2.08E-10		Pa-231	4.06E-11	8.49E-09
Al-26	9.69E-09	2.03E-06		Pm-147	8.11E-05	1.69E-02
Am-241	7.60E-04	1.59E-01		Pr-144	2.48E-12	5.18E-10
Am-242m	1.09E-06	2.28E-04		Pu-238	2.38E-04	4.97E-02
Am-243	1.24E-07	2.59E-05		Pu-239	9.36E-05	1.96E-02
Ba-137m	7.08E-03	1.48E+00		Pu-240	3.44E-05	7.19E-03
Bk-249	2.86E-33	5.98E-31		Pu-241	1.62E-04	3.39E-02
C-14	5.53E-08	1.16E-05		Pu-242	2.83E-07	5.91E-05
Ce-144	2.48E-12	5.18E-10		Pu-244	1.33E-10	2.78E-08
Cf-249	1.05E-24	2.19E-22		Ra-226	1.87E-07	3.91E-05
Cm-242	3.13E-24	6.54E-22		Rh-106	1.93E-10	4.03E-08
Cm-243	1.83E-08	3.82E-06		Ru-106	1.93E-10	4.03E-08
Cm-244	3.51E-05	7.34E-03		Sb-125	5.31E-06	1.11E-03
Cm-245	4.50E-10	9.41E-08		Sb-126	2.90E-07	6.06E-05
Cm-247	1.68E-22	3.51E-20		Sb-126m	2.07E-06	4.33E-04
Cm-248	3.87E-23	8.09E-21		Se-79	1.10E-06	2.30E-04
Co-60	3.03E-05	6.33E-03		Sm-151	3.21E-03	6.71E-01
Cs-134	1.68E-08	3.51E-06		Sn-126	2.07E-06	4.33E-04
Cs-135	2.13E-08	4.45E-06		Sr-90	4.07E-02	8.51E+00
Cs-137	7.60E-03	1.59E+00		Tc-99	1.95E-05	4.08E-03
Eu-152	8.61E-06	1.80E-03		Te-125m	1.30E-06	2.72E-04
Eu-154	9.39E-05	1.96E-02		Th-229	6.53E-08	1.36E-05
Eu-155	8.36E-05	1.75E-02		Th-230	1.86E-07	3.89E-05
H-3	1.06E-06	2.22E-04		U-232	9.67E-10	2.02E-07
I-129	9.23E-11	1.93E-08		U-233	4.84E-07	1.01E-04
Na-22	1.52E-08	3.18E-06		U-234	3.11E-07	6.50E-05
Nb-94	4.90E-08	1.02E-05		U-235	3.68E-09	7.69E-07
Ni-59	2.18E-06	4.56E-04		U-236	5.94E-09	1.24E-06
Ni-63	1.81E-04	3.78E-02		U-238	1.82E-07	3.80E-05
Np-237	1.03E-07	2.15E-05		Y-90	4.07E-02	8.51E+00

4.3 Conservatisms in Assigned Inventory

To assign the FDB-5 and FDB-6 closure inventories, this document uses an approach similar to the one used in the FTF PA to determine the FTF piping systems residual material. Using this approach results in there being several conservatisms inherent in the final FDB-5 and FDB-6 inventories. The following conservatisms are present in the assigned inventory for FDB-5 and FDB-6:

- The radiological and chemical inventory assigned to FDB-5 and FDB-6 conservatively assumes a non-negligible accumulation of residue on the DB surfaces (jumpers and floors). For example, approximately 5.3 gallons of residual sludge slurry is assumed to remain on the FDB-6 floor (170 square feet of FDB-6 floor times 0.031 gallons/square feet). Camera inspection confirmed that the vault and sump walls are clean with a minimal accumulation of material on the vault floor (e.g., a nominal 0.3 gallons on the FDB-6 floor), as would be expected in FDBs cleaned by flushing. [U-ESR-F-00092, U-ESR-F-00094].
- The calculated transfer line residue surface concentrations (from Table 3.3-11 of the FTF PA) used in the FDB-5 and FDB-6 inventory assignment are decayed only to September 30, 2020, consistent with the FTF closure date assumed in the FTF PA. The date of FTF closure will in fact be much later with some of the radionuclides of interest (e.g., Cs-137, Sr-90) being overrepresented in the FDB-5 and FDB-6 inventory because additional decay between 2020 and the date of actual FTF closure is not accounted for.
- The transfers through FDB-5 and FDB-6 were of supernate (evaporator feed and concentrated supernate), not sludge slurry. The calculated transfer line residue surface concentrations assume sludge slurry as the starting material when the flushed material would be dried salt which would contain significantly less long-lived transuranic radionuclides of concern.
- The assigned inventory for FDB-5 contained significantly more radioactivity than would be indicated by the two surveys of FDB-5 performed in 2020. The maximum radioactivity during the two surveys correlated to 5.0E-04 Ci/ft^2 beta-gamma and 2.5E-08 Ci/ft^2 alpha. For comparison, the FDB-5 inventory assignment based on the transfer line concentrations calculated in the FTF PA (Table 3.3-11) had 4.07E-02 Ci/ft^2 for Sr-90 (the primary beta-gamma source) and 2.38E-04 Ci/ft^2 for Pu-238 (the primary alpha source). [SRS-REG-2007-00002] The survey readings would be much higher if the assigned inventory were actually present.

5.0 CONCLUSION

FDB-5 and FDB-6 closure inventories have been assigned using a similar approach to the one used in the FTF PA to determine the FTF piping systems residual material. This approach results in a reasonably conservative final FDB-5 and FDB-6 inventory. The chemical and radiological inventories at closure are presented in Tables 4.1-1 and 4.1-2 for FDB-5 and in Tables 4.2-1 and 4.2-2 for FDB-6.

6.0 REFERENCES

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