**PROJECTED RADIONUCLIDE INVENTORIES OF DWPF
GLASS FROM CURRENT WASTE AT TIME OF PRODUCTION
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by

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**PROJECTED RADIONUCLIDE INVENTORIES OF DWPF GLASS
FROM CURRENT WASTE AT TIME OF PRODUCTION**

INTRODUCTION AND SUMMARY

The Waste Acceptance Preliminary Specifications (WAPS)¹ require that the DWPF estimate the inventory of long-lived radionuclides present in the waste glass, and report the values in the Waste Form Qualification Report. In this report, conservative (biased high) estimates of the radionuclide inventory of glass produced from waste currently in the Tank Farm are provided. In most cases, these calculated values compare favorably with actual data. In those cases where the agreement is not good, the values reported here are conservative.

SPECIFICATION

The WAPS specification for radionuclide inventory projections (Specification 1.2.1) requires that

"The producer shall report the estimated inventory of radionuclides (in Curies) that have half-lives longer than 10 years and that are or will be present in concentrations greater than 0.05 percent of the total radioactive inventory for each waste type at any time up to 1100 years after production. The producer shall also report the upper limit of all radionuclides for any canistered waste form. These estimates shall be indexed to the year 2025. The inventory at year 3125 shall also be provided.

The producer shall provide in the WQR estimates of the total quantities of individual radionuclides to be shipped to the repository and the estimated error in the values. The producer shall also provide in the WQR estimates of the inventories for each waste type and the estimated error."¹

The DWPF will provide the required estimates for each of the sludge batches of current waste which will be fed to the DWPF (a "waste type," in terms of the specification), as well as for future waste generation.² In this report, estimates are developed for the first four sludge batches to the DWPF, at time of production.

RADIONUCLIDES TO BE REPORTED

The DWPF curie balance³ (which defines the radionuclide inventory of the design-basis glass) has been used to define the set of radionuclides to be reported to the repository (Table 1). All of the radionuclides in this set have a half-life > 10 years, and

constitute at least 0.01 % (on a curie basis) of the radionuclide inventory of the design-basis glass at the time of production, or at some later time up to 1100 years after production. This fixed set of species was chosen because of the difficulty of determining which radionuclides will constitute 0.05 % of either a single canister, or even the entire ensemble of canisters, in the time frame of interest.⁴ Choosing a more stringent limit (0.01 %) assures that all radionuclides that must be reported are included.

TABLE 1
RADIONUCLIDES TO BE REPORTED*

Ni-59	Th-230
Ni-63	U-234
Se-79	U-238
Sr-90	Np-237
Zr-93	Pu-238
Nb-93m	Pu-239
Tc-99	Pu-240
Pd-107	Pu-241
Sn-126	Pu-242
Cs-135	Am-241
Cs-137	Am-243
Sm-151	Cm-244

* Includes all radionuclides with half-lives greater than 10 years, and with concentration greater than 0.01 % of the total curie inventory of the design-basis glass at any time up to 1100 years.

SOURCES OF DATA

The radionuclide inventory projections are based on several sources of data. These include:

- DOE's Integrated Data Base.⁵ This document details waste generation, waste immobilization, and waste storage plans at SRS, as

well as data from other DOE sites. It does not include many of the radionuclides of interest, but is the primary source for Sr-90 and Cs-137, which make up the majority of the activity in the waste (It should be noted that it also contains values for Tc-99; however, these are known to be in error by a factor of at least 10, and more likely 20. These have been corrected in the most recent submittal for this report.). The Cs-137, Ba-137m, Sr-90, and Y-90 values out to the year 2009 are collected in Table 2, as are summary values from the Integrated Data Base.

TABLE 2
DATA FROM INTEGRATED DATA BASE, 1991

Average annual content of radionuclides in glass (kCi/m³)*

<u>YEAR</u>	<u>Sr-90</u>	<u>Y-90</u>	<u>Cs-137</u>	<u>Ba-137m</u>
1993 [†]	13.1	13.1	123.4	113.6
1994	12.0	12.0	67.9	62.5
1995	11.7	11.7	69.0	63.4
1996	79.3	79.3	47.4	43.6
1997	89.5	89.5	36.8	33.8
1998	75.3	75.3	45.9	42.3
1999	73.9	73.9	42.6	39.2
2000	63.4	63.4	28.2	25.9
2001	57.8	57.8	23.6	21.7
2002	49.7	49.7	20.0	18.4
2003	44.9	44.9	17.6	16.2
2004	41.4	41.4	15.9	14.6
2005	43.3	43.3	16.4	15.1
2006	45.2	45.2	16.8	15.4
2007	42.7	42.7	15.5	14.3
2008	37.4	37.4	19.5	17.9
2009	66.9	66.9	26.0	24.0

* 0.625 m³ of glass in each canister

[†] Assumed DWPF startup in September, 1993

• The DWPF curie balance.³ As noted above, this was the basis for determining which radionuclides to report. The curie balance provided the basis for biological shielding, process cooling, and environmental release containment requirements for the design of the DWPF. The curie balance (which describes the radionuclide inventory of the design-basis glass) represents an upper bound in terms of the dose rate, and the heat generation rate, expected from DWPF canistered waste forms. The amount of each of the radionuclides

which would be reported in the Production Records for a canister containing the design-basis glass is shown in Table 3.

TABLE 3
RADIONUCLIDE INVENTORY OF THE DWPF DESIGN-BASIS GLASS
(5-year-old sludge, 15-year-old supernate)

<u>Radionuclide</u>	<u>Inventory (Ci/canister)</u>
Ni-59	2.39E-02
Ni-63	2.97E+00
Se-79	1.70E-01
Sr-90	4.82E+04
Zr-93	1.12E+00
Nb-93m	1.12E+00
Tc-99	3.07E+00
Pd-107	1.47E-02
Sn-126	4.38E-01
Cs-135	9.92E-02
Cs-137	4.33E+04
Sm-151	2.39E+02
Th-230	2.00E-06
U-234	3.42E-02
U-238	1.05E-02
Np-237	8.86E-03
Pu-238	1.48E+03
Pu-239	1.29E+01
Pu-240	8.67E+00
Pu-241	1.66E+03
Pu-242	1.22E-02
Am-241	1.10E+01
Am-243	5.79E-03
Cm-244	1.07E+02
TOTAL	2.35E+05

• Projections of the compositions of the glasses which will be made from the first four batches of sludge to be processed in the Tank Farm.⁶⁻⁹ Although these are primarily projections of the chemical compositions of the individual batches, they also contain information about some of the radionuclides of interest taken from analyses and from waste generation flowsheets. The data in the first portion of Table 4 represent the mass flow of the particular species into the canister as a part of the glass. The mass fraction in the glass of that species is thus the mass flow of the species divided by the total mass flow of glass. The last two parts of the Table contain estimates of the U and Pu speciation of each batch, based primarily on waste generation flowsheets from SRS' Separations areas.

TABLE 4
REPORTABLE RADIOACTIVE COMPONENTS IN DWPF PROJECTIONS

<u>Species</u>	<u>Mass Flow to the Canister (lb/hr)</u>			
	<u>Batch 1</u>	<u>Batch 2</u>	<u>Batch 3</u>	<u>Batch 4</u>
Group A*	0.226	0.311	0.238	0.232
Group B*	0.511	1.01	0.579	0.680
Pd	0.0182	0.0396	0.0322	0.0344
PuO ₂	0.00577	0.0136	0.0146	0.000494
TcO ₂	0.0212	0.0334	0.0191	0.0212
U ₃ O ₈	1.20	5.25	7.21	0.904
Total Glass	228.	228.	228.	114.

*Group A contains 1.66 wt% Se; Group B contains 30.49 wt% Zr, 5.23 % Sm, 0.278 % Sn, 0.244 % Np, 0.0618 % Am, $4.24 \cdot 10^{-5}$ % Cm-244, and $3.39 \cdot 10^{-6}$ % Nb.

<u>Radionuclide</u>	<u>Speciation of Uranium (wt%)</u>			
U-233	0.01	0.01	0.01	0.13
U-235	0.73	0.44	0.56	1.24
U-238	99.23	99.55	99.43	98.63

<u>Radionuclide</u>	<u>Speciation of Plutonium (wt%)</u>			
Pu-238	6.03	9.46	5.66	17.27
Pu-239	88.01	85.49	88.00	82.73
Pu-240	4.08	3.82	4.58	0.0
Pu-241	0.19	0.62	1.64	0.0
Pu-242	1.69	0.61	0.12	0.0

- The assumed processing schedule for each sludge batch,¹⁰ and estimates of canister production.¹¹ The assumed processing schedule is needed so that the values in Table 2 can be assigned to the appropriate sludge batch. The estimates of canister production are primarily of importance in determining the total amount of radionuclides contained in the glass produced from each sludge batch. Based on the information in reference 11, it is assumed that 910 canisters will be produced from Batch 1, 987 canisters from Batch 2, 1002 canisters from Batch 3, and 751 canisters from Batch 4.

- In addition, new analytical data (primarily from ICP-MS analyses of actual sludges, which will be reported in a supporting document for Volume 4 of the Waste Form Qualification Report) for some of the trace radionuclides have also been considered in making the estimates. Of particular importance are the values for Pu-238 (41 Ci/canister), Pu-239 (3.4 Ci/canister), Am-241 (6.4 Ci/canister), and Cm-244 (3.7 Ci/canister) for waste which will constitute approximately one-third of Batch 1 (This waste is currently stored in Tank 51, but originally came from the waste tanks identified in references 10 and 11). Although not used directly, these values have been compared to the projections, to evaluate the projections' reasonableness.

PROJECTIONS OF INVENTORIES OF BATCHES 1 THROUGH 4

The projected radionuclide inventories at time of production for the glass which will be produced from sludge Batches 1 - 4 are shown in Table 5. In general, these were calculated by using the most representative value available. When it was not possible to decide on this basis, the values for the design-basis glass were used. In these cases, the projected values are probably conservative (higher) compared to actual values. The details of these calculations for the inventory in a canister of each type of glass are discussed below.

- The Ni-59 and Ni-63 contents of each type of glass were calculated from the ratio of their contents in the design-basis glass to that of Am-243. Since all are activation products, it was assumed that these ratios should be approximately constant for each type of glass. The calculated amount of Ni-59 (or Ni-63) in a particular type of glass is this ratio ($[\text{Ni-59 or -63}]/[\text{Am-243}]$ for the design-basis glass) multiplied by the Am-243 content of that type of glass.

- Se-79 was determined from the values in Table 4. The mass fraction of Se in each type of glass was calculated from the mass flow of "Group A" for the glass divided by 228. lb/hr, and then multiplied by 0.0166 (the weight fraction of Se in Group A). This value was then multiplied by $1.68 \cdot 10^6$ g/canister (=3710 lb), to determine the mass of Se in a canister. Since the Se value reflects several isotopes (Se-79, Se-80, Se-82), the mass of Se-79 was calculated by

$$\text{Mass of Se-79 per canister} = m(\text{Se})_t \cdot (\text{FY}(\text{Se-79}) \cdot 79) / \\ [(\text{FY}(\text{Se-79}) \cdot 79) + (\text{FY}(\text{Se-80}) \cdot 80) + (\text{FY}(\text{Se-82}) \cdot 82)]$$

where $m(\text{Se})_t$ = total mass of Se in the canister, and FY signifies the fission yield of the particular isotope.¹² The mass of Se-79 per canister (in g) was then multiplied by the specific activity of Se-79.¹³

- The values for Sr-90 and Cs-137 were calculated from the values in Table 2, and the time required to process each sludge Batch in reference 10. These values are believed to be the most representative of those for the actual waste. The values in Table 2 were averaged for each batch, and then multiplied by 0.625 (to convert from Ci/m³ to Ci/canister).

- Zr-93, Nb-93m, Sn-126, Np-237, Am-241, and Am-243 were calculated from the values in Table 4. All are members of Group B. The mass of each per canister for each type of glass was determined in a manner similar to that described for Se-79. For each, the mass was then multiplied by the specific activity¹³ to obtain the inventory in curies/canister.

The measured amount of Am-241 in the Tank 51 samples is less than the projected Batch 1 value by roughly 15%. In view of the crudeness of the calculation, this agreement is quite good.

- The inventory of Tc-99 was calculated from the amounts of TcO₂ for each of the projected chemical compositions in Table 4. The amount of TcO₂ in a canister of each type of glass was converted to Tc-99 by multiplying by the ratio of the molecular weights of the metal and the metal oxide. These were then converted to curies/canister by multiplying by the specific activity. It should be noted that there are also values for Tc-99 in the Integrated Data Base.⁵ These values should not be used for any purpose, because of serious inaccuracies.

- The Pd-107 contents at time of production were calculated from the values of Pd in Table 4. The mass flow values for Pd were converted to mass per canister, in the same manner as described for Se-79. Since the Pd value reflects several isotopes (Pd-105, Pd-106, Pd-107, Pd-108, Pd-110), the fraction of Pd-107 was calculated by

$$\text{Mass of Pd-107 per canister} = m(\text{Pd})_t \cdot (\text{FY}(\text{Pd-107}) \cdot 107) / \\ [(\text{FY}(\text{Pd-105}) \cdot 105) + (\text{FY}(\text{Pd-106}) \cdot 106) + (\text{FY}(\text{Pd-107}) \cdot 107) + \\ (\text{FY}(\text{Pd-108}) \cdot 108) + (\text{FY}(\text{Pd-110}) \cdot 110)]$$

where $m(\text{Pd})_t$ = total mass of Pd in the canister, and FY signifies the fission yield of the particular isotope.¹² The mass of Pd-107 per canister (in g) was then multiplied by the specific activity

of Pd-107.¹³

- The Cs-135 content at time of production was calculated as the ratio of the Cs-135 and Cs-137 contents of the design-basis glass, multiplied by the Cs-137 content of each type of glass. No other information is available for Cs-135; analyses of initial precipitate feed to the DWPF will be used to update these estimates.

- The Sm-151 contents at time of production were calculated from the values for Group B and Sm in Table 4. The mass flow values for Sm were converted to mass per canister, in the same manner as described for Se. Since the Sm value reflects several isotopes (Sm-147, Sm-149, Sm-151, Sm-152, Sm-154), the fraction of Sm-151 was calculated by

$$\text{Mass of Sm-151 per canister} = m(\text{Sm})_t \cdot (\text{FY}(\text{Sm-151}) \cdot 151) / \\ [(\text{FY}(\text{Sm-147}) \cdot 147) + (\text{FY}(\text{Sm-149}) \cdot 149) + (\text{FY}(\text{Sm-151}) \cdot 151) + \\ (\text{FY}(\text{Sm-152}) \cdot 152) + (\text{FY}(\text{Sm-154}) \cdot 154)]$$

where $m(\text{Sm})_t$ = total mass of Sm in the canister, and FY signifies the fission yield of the particular isotope.¹² The mass of Sm-151 per canister (in g) was then multiplied by the specific activity of Sm-151,¹³ to obtain the value in Table 5.

- The amounts of U-234 in the as-produced glasses were assumed to be proportional to the amount of uranium in each glass composition in Table 4. The mass flow values for U_3O_8 were converted to the mass of U in each canister in the same manner as described for Tc-99. The U-234 content of each glass at time of production was then calculated as the U-234 content of the design-basis glass multiplied by the ratio of uranium in the two glasses. The values in Table 5 are much larger than those which would result from use of the speciation data in Table 4. There are no other data available for comparison with this data.

- The Th-230 contents were determined by multiplying the curie-content of U-234 in each type of glass by the ratio of the Th-230 and U-234 activities in the design-basis glass (Table 3).

- The amounts of U-238 in the as-produced glasses were assumed to be proportional to the mass flow of uranium in each type of glass (Table 4). The mass flow values for U_3O_8 were converted to the mass of U in each canister in the same manner as described for Tc-99. This mass was then converted to ci/canister, using the specific activity.

- The values for Pu-238 and Pu-239 were both estimated based on the values in Table 4. The total amount of Pu in a canister of each type of glass was calculated from the values in Table 4, in the same manner as described for Tc-99. The isotopic mass fractions of Pu-238 and Pu-239 (from the last portion of Table 4) were then multiplied by the total amount of Pu in each type of glass to

obtain the mass of Pu-238 (or Pu-239) in each canister. These mass values were then multiplied by the specific activities of the isotopes¹³ to obtain curies of the isotope in each canister. The values in Table 5 compare favorably with the Tank 51 values cited earlier.

- For Pu-240, Pu-241, and Pu-242, the amount (in curies) of each in a canister of glass of Batch i was calculated by

$$R(\text{Pu-X})_i = [R(\text{Pu-X})/R(\text{Pu-239})]_{\text{DB}} \cdot R(\text{Pu-239})_i$$

where R denotes activity of the species in the parentheses in Ci/canister; Pu-X denotes Pu-240, Pu-241 or Pu-242; DB means the design-basis glass; and i refers to Batch i. The method used for Pu-238 and Pu-239 was not used for these isotopes because the values from that method were considerably lower. There are no other data available for comparison with this data.

- The content of Cm-244 in each type of glass was calculated by

$$R(\text{Cm-244})_i = [m(\text{Group B})_i/m(\text{Group B})_{\text{DB}}] \cdot R(\text{Cm-244})_{\text{DB}}$$

where R is the activity in curies/canister; i refers to Batch i; m(Group B) denotes the mass flow of Group B; and DB denotes the design-basis. Comparison of the resulting values to the Tank 51 value suggests that the projected values are highly conservative. The content of Cm-244, as a member of Group B, could have been calculated in the same manner as described for Zr-93. This calculation yielded values which were four orders of magnitude below the design-basis value, and two orders of magnitude below the Tank 51 value. For this reason, that method was not used to obtain the values in Table 5.

TOTAL QUANTITIES OF RADIONUCLIDES FOR EACH BATCH

The total quantity of each radionuclide for each Batch is listed in Table 6. These were obtained by multiplying the values in Table 5 by the projected number of canisters for that Batch (910 for Batch 1, 987 for Batch 2, 1002 for Batch 3, and 751 for Batch 4).¹¹ Totaling these values leads to the conclusion that the DWPF will have vitrified $2.2 \cdot 10^8$ curies at time of production of these four Batches.

Some of the totals provide checks of the data. For example, the 9800 Ci of Tc-99 compares favorably to the total of 23,700 Ci currently in the Tank Farm, when the partitioning of Tc between salt and sludge is taken into account. The amounts of Sr-90 and Cs-137 are somewhat lower than those reported in the Integrated Data Base,⁵ but are not unreasonable considering that they represent only the first four batches of material to the DWPF, and not all of the material currently in the Tank Farm.

TABLE 5
PROJECTED RADIONUCLIDE INVENTORIES OF CANISTERS FROM BATCHES 1 - 4
 (at time of production)

<u>Radionuclide</u>	<u>Amount (Ci/canister)</u>			
	<u>Batch 1</u>	<u>Batch 2</u>	<u>Batch 3</u>	<u>Batch 4</u>
Ni-59	1.05E-02	2.08E-02	1.20E-02	2.81E-02
Ni-63	1.31E+00	2.59E+00	1.49E+00	3.49E+00
Se-79	1.55E-01	2.13E-01	1.63E-01	3.18E-01
Sr-90	7.53E+03	5.09E+04	4.08E+04	2.83E+04
Zr-93	4.66E+00	9.21E+00	5.28E+00	1.24E+01
Nb-93m	4.10E-02	8.11E-02	4.65E-02	1.09E-01
Tc-99	2.01E+00	3.16E+00	1.81E+00	4.02E+00
Pd-107	6.09E-03	1.32E-02	1.08E-02	2.30E-02
Sn-126	2.98E-01	5.89E-01	3.38E-01	7.94E-01
Cs-135	1.11E-01	6.21E-02	4.54E-02	2.57E-02
Cs-137	4.85E+04	2.71E+04	1.98E+04	1.12E+04
Sm-151	5.24E+02	1.04E+03	5.94E+02	1.39E+03
Th-230	4.83E-07	2.11E-06	2.90E-06	7.28E-07
Np-237	6.49E-02	1.28E-01	7.35E-02	1.73E-01
U-234	8.22E-03	3.60E-02	4.94E-02	1.24E-02
U-238	2.53E-03	1.10E-02	1.52E-02	3.80E-03
Pu-238	3.88E+01	1.43E+02	9.22E+01	1.90E+02
Pu-239	2.03E+00	4.64E+00	5.13E+00	3.26E+00
Pu-240	1.36E+00	3.12E+00	3.45E+00	2.19E+00
Pu-241	7.38E+00	5.67E+01	1.61E+02	4.20E+02
Pu-242	1.92E-03	4.39E-03	4.85E-03	3.09E-03
Am-241	4.85E+00	9.60E+00	5.50E+00	1.29E+01
Am-243	1.82E-01	3.60E-01	2.06E-01	4.85E-01
Cm-244	1.02E+02	2.02E+02	1.16E+02	1.36E+02
TOTAL	5.67E+04	7.95E+04	6.16E+04	4.17E+04

SOURCES OF ERROR IN SINGLE CANISTER VALUES

The projected inventories in Table 5 are subject to several sources of uncertainty. These include the errors in the calculations, potential Tank Farm process variations, and DWPF process variations. Of these, the first two are the most significant.

The errors in the calculations vary for each radionuclide. Based

TABLE 6
PROJECTED TOTAL AMOUNT OF RADIONUCLIDES VITRIFIED IN BATCHES 1 - 4
 (at time of production)

<u>Radionuclide</u>	<u>Amount (Ci/Batch)</u>				<u>TOTAL</u>
	<u>Batch 1</u>	<u>Batch 2</u>	<u>Batch 3</u>	<u>Batch 4</u>	
Ni-59	9.60E+00	2.06E+01	1.20E+01	2.11E+01	6.32E+01
Ni-63	1.19E+03	2.56E+03	1.49E+03	2.62E+03	7.86E+03
Se-79	1.41E+02	2.10E+02	1.63E+02	2.39E+02	7.54E+02
Sr-90	6.85E+06	5.02E+07	4.09E+07	2.13E+07	1.19E+08
Zr-93	4.24E+03	9.09E+03	5.29E+03	9.32E+03	2.79E+04
Nb-93m	3.73E+01	8.00E+01	4.66E+01	8.20E+01	2.46E+02
Tc-99	1.83E+03	3.12E+03	1.81E+03	3.02E+03	9.78E+03
Pd-107	5.54E+00	1.31E+01	1.08E+01	1.73E+01	4.67E+01
Sn-126	2.71E+02	5.82E+02	3.39E+02	5.96E+02	1.79E+03
Cs-135	1.01E+02	6.13E+01	4.55E+01	1.93E+01	2.27E+02
Cs-137	4.41E+07	2.67E+07	1.98E+07	8.41E+06	9.91E+07
Sm-151	4.77E+05	1.02E+06	5.95E+05	1.05E+06	3.14E+06
Th-230	4.40E-04	2.09E-03	2.91E-03	5.47E-04	5.98E-03
Np-237	5.91E+01	1.27E+02	7.37E+01	1.30E+02	3.89E+02
U-234	7.48E+00	3.55E+01	4.95E+01	9.31E+00	1.02E+02
U-238	2.30E+00	1.09E+01	1.52E+01	2.86E+00	3.13E+01
Pu-238	3.53E+04	1.42E+05	9.23E+04	1.43E+05	4.12E+05
Pu-239	1.85E+03	4.58E+03	5.14E+03	2.45E+03	1.40E+04
Pu-240	1.24E+03	3.08E+03	3.46E+03	1.65E+03	9.43E+03
Pu-241	6.71E+03	5.60E+04	1.61E+05	3.16E+05	5.40E+05
Pu-242	1.75E+00	4.33E+00	4.86E+00	2.32E+00	1.33E+01
Am-241	4.42E+03	9.47E+03	5.51E+03	9.70E+03	2.91E+04
Am-243	1.66E+02	3.55E+02	2.07E+02	3.64E+02	1.09E+03
Cm-244	<u>9.32E+04</u>	<u>2.00E+05</u>	<u>1.16E+05</u>	<u>1.02E+05</u>	<u>5.11E+05</u>
TOTAL	5.16E+07	7.84E+07	6.17E+07	3.13E+07	2.23E+08

on the limited comparisons reported above, the projected inventories agree with other reported values within about 25% for the more concentrated radionuclides, but only to within a factor of 100 for more dilute species (e.g., Cm-244). Thus, at least for the dilute radionuclides, this is the dominant source of uncertainty.

Potential variations in Tank Farm processing are probably the

largest source of uncertainty in the inventories of individual canisters for the more concentrated radionuclides. As an example, a canister containing the design-basis waste glass would contain 95 kCi/canister of reportable radionuclides, while the first glass produced by the DWPF will contain approximately 57 kCi/canister, at time of production. Thus, if younger waste is mixed with the older waste in Batch 1, the inventory per canister would significantly increase. Because of the limited number of Tank Farm samples which have been analyzed for these radionuclides, it is not possible to quantify this potential variability. However, the magnitude of this increase is probably bounded by the maximum variation in analytical values for any individual radionuclide in Tank Farm samples, which is approximately a factor of ten. Thus, potential variations in Tank Farm processing are large sources of uncertainty in the inventory of individual canisters, but are difficult to quantify.

The uncertainty in the projected inventories per canister due to variations in the DWPF process is easily quantified, but probably much less significant than the other uncertainties. Pilot plant experience indicates the relative variability for the DWPF process should be on the order of 20 %, including batch-to-batch variations and variations in canister filling. Compared to the large uncertainties due to errors in the calculations and potential variations in Tank Farm processing, DWPF process variations appear of minor importance.

SOURCES OF ERROR IN TOTAL ACTIVITY VITRIFIED

The total activity vitrified in each batch is subject to the same errors identified above as well as errors in the projected number of canisters for each sludge batch. The assumed solids to volume ratio is most likely the largest contributor to the error in this case. As is discussed in reference 11, the total uncertainty in the number of canisters may be as high as 60%.

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