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7. Abstract

This document reports results of an Initial Hazard Categorization for the Hanford Site Tank Farms using the procedure set forth in DOE Standard 1027-92. For documentation purposes the initial Hazard Categorization calculations were made for two cases. The first case treats each tank as an individual segmented facility. The second case treats all 177 of the Hanford Site tanks as a single segmented facility. Calculations were performed using conservative estimates of the tank waste radioactive inventories. The initial hazard category is Hazard Category 2 when each tank is treated as an individual facility segment, and is also Hazard Category 2 when the 177 tanks are treated collectively as a single facility segment.

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CONTENTS

LIST OF TABLES

LIST OF TERMS

ASA	Accelerated Safety Analysis
AWF	aging waste facility
DOE	U.S. Department of Energy
DST	double-shell tanks
PUREX	plutonium-uranium extraction
SST	single-shell tanks
WHC	Westinghouse Hanford Company

INITIAL HAZARD CATEGORIZATION FOR THE HANFORD SITE TANK FARMS

1.0 INTRODUCTION AND SUMMARY

This document addresses single-shell and double-shell tank farm facilities located in the 200 East and 200 West Areas of the Hanford Site. Supporting facilities and systems (e.g., ventilation) are included; not included are miscellaneous underground storage tanks and the 242-A, 242-S, and 242-T Evaporators. Initial hazard categories were determined using the procedure set forth in U.S. Department of Energy (DOE) Standard 1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. The initial hazard categorization calculations in this document are purely objective in that they are strictly based on the numerical limits in DOE Standard 1027-92.

Initial hazard category calculations are documented for two different cases. The first case assumes an event impacts only a single tank. The second case assumes that an event could be postulated that would affect all 177 of the Hanford Site tanks (e.g., an earthquake), although the likelihood of this occurring is extremely small.

The hazard categorization procedure in DOE Standard 1027-92 requires that conservative estimates of the radioactive inventory contained in a facility be compared to threshold quantities of radionuclides that are listed in DOE Standard 1027-92, Table A.1, for Hazard Category 2 and 3 facilities. The fraction of the threshold quantity is calculated for each radionuclide by dividing the inventory of a particular nuclide by the appropriate threshold quantity from Table A.1. The fractions of the threshold quantity for each radionuclide are then added to obtain a sum-of-fractions of the threshold quantity values that is compared to 1. If the sum-of-fractions value is greater than 1 for ratios calculated using the Hazard Category 2 threshold quantities, then the facility is at least Hazard Category 2. Threshold quantities are not provided for designating a facility as Hazard Category 1. Note that DOE Standard 1027-92 states that a facility may be Hazard Category 1 if there "is a potential for significant offsite consequences."

The sum-of-fractions of the DOE Standard 1027-92 Hazard Category 2 threshold quantities is much greater than 1 for the worst tank in each of the three tank groups (single-shell tanks [SSTs], double-shell tanks [DSTs], Aging Waste Facility [AWF] tanks). Therefore, the initial hazard category for each facility grouping (SSTs, DSTs, AWF tanks) is at least Hazard Category 2. Although the sum-of-fractions is very high, there are no numerical upper limits on the Hazard Category 2 threshold quantities that result in designating the facility segments as Hazard Category 1.

For a scenario involving a release of the total Hanford Site tank waste, the sum-of-fractions of the DOE Standard 1027-92 Hazard Category 2 threshold quantities is much greater than 1. Therefore, the initial hazard category for the Hanford Site tank farms is at least a Hazard Category 2 when the 177 tanks are treated collectively.

The initial hazard categorization calculations in this document are purely objective in that they are strictly based on the numerical limits in DOE Standard 1027-92. The results of this objective evaluation will be considered in conjunction with extensive accident analyses already documented in WHC-SD-WM-SAR-065, *Interim Chapter 3.0 Hazard and Accident Analysis* (WHC 1995), to respond to the "significant offsite consequences" criterion for Hazard Category 1. This document and WHC-SD-WM-SAR-065 (WHC 1995) will be used to support the Westinghouse Hanford Company (WHC) recommendation of Hazard Category 2 for the Hanford Site tank farms.

Section 2.0 provides details on the calculation of the total facility inventory, and Section 3.0 addresses the calculation of the sum-of-fractions values.

2.0 TOTAL FACILITY INVENTORY

2.1 INTRODUCTION

Hanford Site tank wastes are not uniform in either composition or distribution. They were produced by separations plants that used different processes, and after being discharged from these separations plants, they were subjected to different precipitative and evaporative processes to reduce their volume. Wastes were then pumped from tank to tank and farm to farm, complicating efforts to characterize the waste in individual tanks and tank farms. Hence the exact radioactive inventory in each tank is not known with a high degree of certainty. However, to perform the initial hazard categorization, it is necessary to obtain an estimate of the total inventory of radioactive material in a tank and the total inventory contained in all of the tanks despite the lack of detailed tank-by-tank waste characterization data.

In this document, the tanks are separated into three major tank groupings or facility segments: SSTs, DSTs, and AWF tanks. The AWF tanks are those in tanks farms 241-AY and 241-AZ. The tanks were grouped or segmented in this manner because the waste contained in each of the tanks within these tank groupings is generally similar and because characterization data is available for these tank groups. Although the AWF tanks are DSTs, they are treated separately because of the particular waste form they contain, or are allowed to contain, which is waste that was discharged from the Plutonium-Uranium Extraction (PUREX) facility in the 1980's.

The following sections describe the process used to establish conservative estimates of the tank waste radionuclide inventories for the single tank release case and the total Site release case. Section 2.2 addresses tank waste radionuclide activity concentrations, Section 2.3 deals with facility segmentation, and Section 2.4 discusses the derivation of the radioactive inventories.

2.2 TANK WASTE RADIONUCLIDE ACTIVITY CONCENTRATIONS

As mentioned above, the inventory of radioactive material in the tanks is needed in order to perform the initial hazard categorization. This requires tank waste characterization data. In the case of the single tank release, inventory estimates were conservatively made using maximum sample activity concentrations from available tank waste characterization data (see Section 2.2.1). However, it would be overly conservative to use the maximum sample activity concentrations to calculate the total Hanford Site tank radioactive material inventory for a release involving all the tanks. Therefore, the mean activity concentrations were used for this case (see Section 2.2.2).

2.2.1 Tank Waste Radionuclide Activity Concentrations Used for the Single Tank Release

WHC-SD-WM-SAR-065 (WHC 1995), also known as the Tank Farms Accelerated Safety Analysis (ASA), contains maximum sample activity concentrations that were selected from hundreds of sample results contained in a database consisting of all the useable sample sources or tank waste characterization data calculated as of December 1994. The database was created by collecting and evaluating historical sample data and tank content estimates derived from flow sheet-based models and intertank transfer records. It includes the following sources of data:

- *Radionuclide and Chemical Inventories for the Double-Shell Tanks*, WHC-SD-WM-TI-543 (Van Vleet 1993a)

  Radionuclide and Chemical Inventories for the Single-Shell Tanks, WHC-SD-WM-TI-565 (Van Vleet 1993b)

- *High-Level Waste Tank Subcriticality Safety Assessment*, WHC-SD-WM-SARR-003 (Braun 1994), the tank sample analysis data base prepared by the WHC Risk Assessment Technology Group
- Files of sample data collected by the Tank Characterization Program
- Tank characterization reports
- The Tank Contents Data Base maintained by Pacific Northwest Laboratories for WHC
- The Track Radioactive Components (TRAC) data base (Jungfleisch 1984), which does not report actual sample results but does give calculated concentrations of radionuclides derived from process flow sheets
- *Estimated Chemical and Radiochemical Inventories Spreadsheet: NE Quadrant, A, AX, B, BX, BY, C Farms* (Agnew 1994a) and *Estimated Chemical and Radiochemical Inventories Spreadsheet: SW Quadrant, S, SX, U Farms* (Agnew 1994b), which do not report actual sample results but give calculated concentrations of radionuclides and chemicals

derived from process flow sheets and historical data on transfers in and out of the Hanford Site tanks.

The data has been compiled in electronic files by ICF Kaiser and is the largest single collection of usable sample data at the Hanford Site.

Tank Waste Source Term Inventory Validation, WHC-SD-WM-ER-400 (Cowley 1995), contains tables and plots of the activity concentration data from the database. The database is separated into three major tank groupings: SSTs, DSTs (excluding AWF tanks), and AWF tanks. For each of the three major groupings, data are presented for both liquid and solid phases. These six waste types (i.e., SST liquids and solids, DST liquids and solids, and AWF tank liquids and solids) encompass all tank waste types. The database contains activity concentrations for ^{60}Co, ^{90}Sr, ^{137}Cs, ^{154}Eu, ^{237}Np, ^{238}Pu, $^{239/240}Pu$, ^{241}Pu, ^{241}Am, ^{244}Cm. These 11 radionuclides and their daughters were selected because they contribute more than 99% of the total inhalation dose according to the data contained in Van Vleet (1993a and 1993b).

The maximum sample activity concentrations were selected by evaluating the tables and plots of the activity concentration data in Cowley (1995) and selecting the highest value for each radionuclide that did not conflict with known process parameters or that did not contain obvious errors. This evaluation was performed by a team of experienced WHC personnel who were very familiar with the history and processes used at Hanford. The team included representatives from the analytical laboratory, process chemistry, waste tank operations, Tank Waste Remediation Systems engineering, ICF Kaiser, and safety analysis. Cowley (1995) documents the evaluation performed by the team to select the maximum sample activity concentrations. These activity concentrations were used to calculate accident consequences in the Tank Farms ASA (WHC 1995).

Table 1 contains the maximum sample activity concentrations reported in the Tank Farms ASA (WHC 1995) for each of the three tank groupings. Note that values are given for both liquid and solid waste types and that the activities are decayed to the end of 1994. The values in Table 1 represent the maximum sample activity concentrations selected by the sample evaluation team (Cowley 1995) for the 11 radionuclides that contribute more than 99% to the total inhalation dose. The activity concentrations for the remaining 12 radionuclides in Table 1 are the highest values reported in Van Vleet (1993a and 1993b). Since these 12 radionuclides are not major dose contributors, the evaluation team did not go through the same detailed evaluation and selection process that they did for the other 11 radionuclides. The values in Table 1 represent a conservative estimate of the activity concentrations for each of the six tank waste types using the available tank waste characterization data.

2.2.2 Tank Waste Radionuclide Activity Concentrations for the Total Hanford Site Tank Waste Release

As mentioned above, it would be overly conservative to use the maximum sample activity concentrations to calculate the total radioactive inventory for a release involving all 177 of the Hanford Site tanks. A total radioactive inventory calculated in this manner would assume the entire waste volume is a homogeneous mixture containing radionuclides at the maximum sample activity concentrations. In reality, the sample results in Cowley (1995) indicate that a vast majority of the activity concentrations in the tanks are far less than the maximum sample activity concentrations listed in Table 1. Therefore, the mean or average sample activity concentrations were used for the case involving the release of the total Hanford Site tank waste volume.

Table 2 contains the mean sample activity concentrations, which represent the volume-weighted mean sample activity concentrations for each radionuclide for each of the six tank waste types (i.e., SST liquids and solids, DST liquids and solids, AWF tank liquids and solids). The tank waste volumes and activity concentrations used in the calculation of the mean sample activity concentrations were taken from Van Vleet (1993a and 1993b). Note that although the activity concentrations were taken from Van Vleet (1993a and 1993b), the Van Vleet data were slightly modified so that the maximum sample activity concentrations from the modified data matched those selected by the sample review team (see Section 2.2.1). *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in ASA Consequence Assessments*, WHC-SD-WM-SARR-016 (Savino 1995), documents the modifications made to the Van Vleet data along with the calculation of the mean sample activity concentrations.

2.3 SEGMENTATION OF TANK FARMS INVENTORY

Segmentation may be defined as the division of hazardous material inventory into areas within the facility for which common cause events would be unlikely to result in accidental release of materials from more than one designated segment. DOE Standard 1027-92 allows for segmentation provided that hazardous material in one facility segment cannot interact with materials in another facility segment.

Several approaches could be taken to segmenting the tanks contained in the tank farms: the SSTs and DSTs are constructed differently; the tanks are also grouped collectively into farms, which are composed of tanks that are physically located near each other; the tanks in the 200 East Area and in the 200 West Area are separated by a distance of a few miles. For purposes of this initial hazard categorization, however, calculations were made assuming the contents of a single tank were impacted by an event, and a second set of calculations was made in which it was conservatively assumed that an event impacted all of the Hanford Site tanks. That is, the first case assumes that each tank can be treated as a single segmented facility, whereas the second case treats all 177 tanks as a single facility.

2.3.1 Segmentation of the Tank Waste for the Single Tank Release

For the single tank release case, data from the *Waste Tank Summary Report for Month Ending December 31, 1994*, WHC-EP-0182-81 (Hanlon 1995), was reviewed to determine which tanks had the largest volume of waste and the highest percentage of solids, since the activity concentrations for the radionuclides that drive the hazard categorization are higher in solids.

For example, the last row in Table 1 shows that the waste volume for the worst SST tank release case was 3.8 x 10^6 L of solids and 0 L of liquids. This is based on data contained in Hanlon (1994) that indicated that tank A-101 had the worst combination of percentage of solids and total waste volume for all of the SST tanks. Essentially the entire waste volume (3.8 x 10^6 L or 1 Mgal) in tank A-101 was solids. Similarly, for the DSTs, tank SY-101 contained 50% solids and had a total volume of 4.4 x 10^6 L (1.16 Mgal). Finally, for the AWF tanks, tank AZ-102 contained 10% solids and had a total volume of 3.8 x 10^6 L (1 Mgal).

Section 2.4.1 discusses how these waste volumes were used along with the maximum sample activities (Section 2.1.1) to provide conservative estimates of single tank inventories for each of the three major tank groups (SSTs, DSTs, and AWF tanks).

2.3.2 Segmentation of the Tank Waste for the Total Hanford Site Tank Waste Release

For the total Hanford Site tank waste release case, data from Hanlon (1994) was reviewed to identify the total tank waste volume for each of the six waste types. These volumes are listed in the last row of Table 2. For example, Table 2 shows that the total SST liquid waste volume is 2.2 x 10^6 L and the total SST solid waste volume is 1.3 x 10^8 L.

Section 2.4.2 discusses how these total waste volumes were used along with the mean sample activities (Section 2.1.2) to provide an estimate of the entire Hanford Site radioactive waste inventory.

2.4 TOTAL RADIOACTIVE INVENTORIES FOR EACH SEGMENTED FACILITY

2.4.1 Tank Waste Radioactive Inventory for the Single Tank Release

Conservative estimates of single tank radioactive waste inventories were made using the worst single tank waste volumes (Section 2.3.1) along with the maximum sample activity concentrations (Section 2.2.1). Table 3 lists the resulting worst-case, single tank radioactive inventories for the three major tank groups (SSTs, DSTs, and AWF tanks).

Note that these inventory estimates are conservative in that they were developed assuming the entire waste volume was a homogeneous mixture containing radionuclides at the maximum sample activity concentrations. As mentioned before, these activity concentrations are the maximum found in any tank within a tank grouping. Therefore it would not be expected that any single tank would contain waste with all of the radionuclide concentrations at the maximum sample activity concentrations. In reality, the sample results in Cowley (1995) indicate that a vast majority of the activity concentrations in the tanks is far less than the maximum sample activity concentrations listed in Table 1.

2.4.2 Tank Waste Radioactive Inventory for the Total Hanford Site Tank Waste Release

Estimates of the Hanford Site tank waste radioactive inventories were made using the total tank waste volumes (Section 2.3.2) along with the mean sample activities (Section 2.2.2). Table 4 lists the resulting total radioactive inventories for the three major tank groups (SSTs, DSTs, and AWF tanks). Although all of the tanks will be treated collectively, data are presented for the three tank groups in the event future calculations need the more detailed data. These inventories assume that the entire waste volume for each of the six tank waste types is a homogeneous mixture containing radionuclides at the mean sample activity concentrations for that waste type.

3.0 INITIAL HAZARD CATEGORIES

3.1 INITIAL HAZARD CATEGORY BASED ON THE RADIOACTIVE WASTE INVENTORY FOR THE SINGLE TANK RELEASE CASE

The Hazard Category 2 threshold quantities from DOE Standard 1027-92 are presented in Table 3 for the worst single tank release case. The sum-of-fractions is much greater than 1 for the worst tank in each of the three tank groups. Therefore, the initial hazard category for each facility grouping is at least a Hazard Category 2. Although the sum-of-fractions is very high, there are no numerical upper limits on the Hazard Category 2 threshold quantities that would result in designating the facility segments Hazard Category 1.

Note that there are five nuclides (^{79}Se, ^{90}Y, ^{125}Sb, ^{129}I, ^{244}Cm) given in the ASA that are not included in the DOE Standard 1027-92 list. All of these nuclides are fission products except ^{244}Cm, which is an alpha emitter. A value of 2.5×10^6 Ci is recommended for the Hazard Category 2 threshold quantity for mixed fission products that are not included in the DOE Standard 1027-92 list. A value of 55 Ci is recommended for alpha emitters. These values were used in Table 3 even though these five nuclides have a negligible impact on the sum-of-fractions value.

3.2 INITIAL HAZARD CATEGORY BASED ON THE RADIOACTIVE WASTE INVENTORY FOR THE TOTAL HANFORD SITE TANK WASTE RELEASE CASE

The Hazard Category 2 threshold quantities from DOE Standard 1027-92 are presented in Table 4 for each of the three tank groups. For a release of the total Hanford Site tank waste, the sum-of-fractions for each of the three tank groups (SSTs, DSTs, and AWF tanks) must be added together. The resulting sum-of-fractions based on the entire Site tank waste is 1.5×10^4 ($8.8 \times 10^3 + 1.8 \times 10^3 + 4.6 \times 10^3$), which is much greater than 1. Therefore, the initial hazard category for the 177 Hanford Site tanks, treated collectively, is at least a Hazard Category 2.

Note that if the tanks are treated on a single tank basis, or are segmented by tank waste type, tank construction, tank farm, or geographical area (200 East or 200 West), the segmented "facilities" would still be classified as Hazard Category 2 because of the large quantity of transuranics contained in any single tank within the tank groups.

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Table 1. Maximum Sample Activity Concentrations for Solid and Liquid Tank Waste.[a]

Nuclide	Activity Concentration, Bq/L					
	SST liquids	SST solids	DST[b] liquids	DST[b] solids	AWF[c] liquids	AWF[c] solids
^{14}C	1.0 E+05	1.2 E+05	2.3 E+05	1.6 E+05	5.8 E+04	1.0 E+05
^{60}Co	1.2 E+07	5.3 E+08	8.8 E+06	1.4 E+07	4.6 E+07	6.1 E+08
^{79}Se	d	1.7 E+04	d	d	d	d
^{90}Sr	1.1 E+10	1.7 E+12	5.1 E+09	3.6 E+10	5.8 E+09	3.0 E+12
^{90}Y	1.1 E+10	1.7 E+12	5.1 E+09	3.6 E+10	5.8 E+09	3.0 E+12
^{99}Tc	1.7 E+07	1.2 E+10	1.1 E+07	6.2 E+07	1.2 E+07	2.8 E+08
^{106}Ru	3.3 E+03	2.4 E+05	d	d	d	d
^{125}Sb	5.3 E+04	2.8 E+08	d	d	d	d
^{129}I	1.0 E+04	6.4 E+06	2.0 E+04	2.0 E+04	4.4 E+01	4.1 E+06
^{134}Cs	2.1 E+05	2.6 E+06	1.1 E+07	1.7 E+07	2.4 E+04	d
^{137}Cs	2.3 E+10	7.5 E+10	6.1 E+10	6.1 E+10	9.2 E+10	1.0 E+11
^{144}Ce	4.3 E+01	1.6 E+03	d	d	d	d
^{147}Pm	d	d	5.7 E+07	d	d	d
^{154}Eu	2.7 E+09	6.6 E+09	4.8 E+07	2.5 E+08	d	1.3 E+10
^{155}Eu	7.5 E+07	6.4 E+06	d	d	d	d
^{237}Np	d	3.0 E+07	2.3 E+05	2.4 E+05	9.2 E+04	9.9 E+08
^{238}Pu	9.3 E+04	1.9 E+08	1.8 E+06	7.2 E+07	2.8 E+03	6.8 E+07
^{239}Pu[e]	3.6 E+07	4.4 E+08	7.6 E+06	1.6 E+09	1.2 E+06	4.4 E+08
^{241}Pu	2.8 E+08	3.5 E+09	2.0 E+07	4.1 E+09	3.7 E+05	1.8 E+09
^{241}Am	3.7 E+07	3.6 E+08	3.4 E+07	2.7 E+09	1.1 E+06	1.1 E+10
^{242}Cm	d	d	1.7 E+02	d	d	3.0 E+03
^{244}Cm	d	d	1.3 E+05	1.1 E+07	d	6.5 E+07
Waste volume for worst single tank[f] (L)	0	3.8 E+06	2.2 E+06	2.2 E+06	3.4 E+06	3.9 E+05

[a]WHC, 1995, *Interim Chapter 3.0 Hazard and Accident Analysis*, WHC-SD-WM-SAR-065, Rev. 0, DRAFT, Westinghouse Hanford Company, Richland, Washington.

[b]Double-shell tanks, excluding the Aging Waste Facility tanks.

[c]Aging Waste Facility tanks (Tank Farms 241-AY and 241-AZ).

[d]No data available in the Tank Farms ASA (WHC 1995). These radionuclides have a negligible impact on the radiological hazard categorization determination because of their low activity concentrations.

[e]The ^{239}Pu activity concentration also includes ^{240}Pu.

[f]Waste volume for each waste type obtained from Hanlon, B. M. 1994, *Waste Tank Summary Report for Month Ending December 31, 1994*, WHC-EP-0182,81, which assumes the worst SST (A-101) contains 100% solids and has a total volume of 1 Mgal; the worst DST (SY-101) contains 50% Solids and a volume of 1.16 Mgal; the worst AWF tank (AZ-102) contains 10% solids and a volume of 1 Mgal.

SST = Single-shell tank.
DST = Double-shell tank.
AWF = Aging waste facility.

Table 2. Mean Activity Concentrations for Solid and Liquid Tank Waste.[a]

Nuclide	Activity concentration, Bq/L					
	SST liquid	SST solids	DST[b] liquid	DST[b] solids	AWF[c] liquid	AWF[c] solids
^{14}C	3.6 E+04	5.8 E+04	7.8 E+04	8.1 E+04	5.2 E+04	8.9 E+04
^{60}Co	4.2 E+06	6.6 E+07	2.4 E+06	1.1 E+06	2.6 E+07	4.1 E+08
^{79}Se	d	1.7 E+04	d	d	d	d
^{90}Sr	7.8 E+08	1.9 E+10	9.5 E+08	2.7 E+09	1.6 E+09	1.2 E+12
^{90}Y	7.8 E+08	1.9 E+10	9.5 E+08	2.7 E+09	1.6 E+09	1.2 E+12
^{99}Tc	4.1 E+06	1.6 E+09	5.1 E+06	8.6 E+06	8.3 E+06	8.8 E+07
^{106}Ru	9.8 E+02	7.2 E+03	d	d	d	d
^{125}Sb	5.3 E+04	1.6 E+07	d	d	d	d
^{129}I	4.2 E+03	8.0 E+05	1.1 E+04	1.5 E+04	4.4 E+01	1.0 E+06
^{134}Cs	1.1 E+05	4.5 E+05	4.2 E+06	2.3 E+06	2.4 E+04	d
^{137}Cs	7.2 E+09	7.5 E+09	1.3 E+10	3.0 E+10	3.2 E+10	3.4 E+10
^{144}Ce	4.2 E+01	6.1 E+02	d	d	d	d
^{147}Pm	d	d	1.2 E+07	d	d	d
^{154}Eu	1.7 E+09	1.4 E+08	4.7 E+07	1.6 E+08	d	8.0 E+09
^{155}Eu	7.5 E+07	6.4 E+06	d	d	d	d
^{237}Np	d	3.0 E+07	2.7 E+04	2.0 E+04	9.2 E+04	3.2 E+08
^{238}Pu	2.0 E+04	1.0 E+07	3.2 E+05	3.4 E+06	2.8 E+03	5.4 E+07
^{239}Pu[e]	1.2 E+06	2.4 E+07	9.5 E+05	5.1 E+07	4.3 E+05	2.6 E+08
^{241}Pu	9.1 E+06	1.9 E+08	4.4 E+06	1.9 E+08	1.9 E+05	1.6 E+09
^{241}Am	8.0 E+05	2.0 E+07	3.6 E+06	8.6 E+07	4.4 E+05	6.1 E+09
^{242}Cm	d	d	8.4 E+01	d	d	3.0 E+03
^{244}Cm	d	d	4.6 E+04	8.0 E+05	d	3.2 E+07
Total volume[f], L	2.2 E+06	1.3 E+08	4.8 E+07	1.7 E+07	1.3 E+07	9.3 E+05

[a]Savino, A. V., 1995, *Tank Farm High Level Waste Compositions and Atmospheric Dispersion Coefficients for Use in ASA Consequence Assessments*, WHC-SD-WM-SARR-016, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[b]Double-shell tanks, excluding the Aging Waste Facility tanks.

[c]Aging Waste Facility tanks (Tank Farms 241-AY and 241-AZ).

[d]No data available in the Tank Farms ASA (WHC, 1995, *Interim Chapter 3.0 Hazard Accident Analysis*, WHC-SD-WM-SAR-065, Rev. 0, Westinghouse Hanford Company, Richland, Washington). These radionuclides have a negligible impact on the radiological hazard categorization determination because their low activity concentrations.

[e]The ^{239}Pu activity concentration also includes ^{240}Pu.

[f]Total volume for each waste type obtained from Hanlon (B. M., 1994, *Waste Tank Summary Report for Month Ending December 31, 1994*, WHC-EP-10182-81, Westinghouse Hanford Company, Richland, Washington.

SST = Single-shell tank.
DST = Double-shell tank.
AWF = Aging waste facility.

Table 3. Estimated Worst Single Tank Waste Inventories based on the Maximum Sample Activity Concentrations.[a]

Nuclide	DOE 1027-92 Category 2 threshold quantity (TQ), (Ci)	Worst single-shell tank		Worst double-shell tank[b]		Worst Aging Waste Facility tank[c]	
		Total inventory[d] (Ci)	Fraction of category 2 TQ	Total inventory[d] (Ci)	Fraction of category 2 TQ	Total inventory[d] (Ci)	Fraction of category 2 TQ
^{14}C	1.4 E+06	1.2 E+01	8.8 E-06	2.3 E+01	1.7 E-05	6.4 E+00	4.6 E-06
^{60}Co	1.9 E+05	5.4 E+04	2.9 E-01	1.4 E+03	7.1 E-03	1.1 E+04	5.6 E-02
^{79}Se[e]	2.5 E+06	1.7 E+00	7.0 E-07	f	f	f	f
^{90}Sr	2.2 E+04	1.7 E+08	7.9 E+03	2.4 E+06	1.1 E+02	3.2 E+07	1.5 E+03
^{90}Y[e]	2.5 E+06	1.7 E+08	7.0 E+01	2.4 E+06	1.0 E+00	3.2 E+07	1.3 E+01
^{99}Tc	3.8 E+06	1.2 E+06	3.2 E-01	4.3 E+03	1.1 E-03	4.1 E+03	1.1 E-03
^{106}Ru	6.5 E+03	2.5 E+01	3.8 E-03	f	f	f	f
^{125}Sb[e]	2.5 E+06	2.9 E+04	1.1 E-02	f	f	f	f
^{129}I[e]	2.5 E+06	6.5 E+02	2.6 E-04	2.4 E+00	9.5 E-07	4.3 E+01	1.7 E-05
^{134}Cs	6.0 E+04	2.7 E+02	4.4 E-03	1.7 E+03	2.8 E-02	2.2 E+00	3.7 E-05
^{137}Cs	8.9 E+04	7.7 E+06	8.6 E+01	7.3 E+06	8.2 E+01	9.5 E+06	1.1 E+02
^{144}Ce	8.2 E+04	1.6 E-01	2.0 E-06	f	f	f	f
^{147}Pm	8.4 E+05	f	f	3.4 E+03	4.0 E-03	f	f
^{154}Eu	1.1 E+05	6.8 E+05	6.1 E+00	1.8 E+04	1.6 E-01	1.4 E+05	1.2 E+00
^{155}Eu	7.3 E+05	6.5 E+02	9.0 E-04	f	f		f
^{237}Np	5.8 E+01	3.1 E+03	5.3 E+01	2.8 E+01	4.8 E-01	1.0 E+04	1.8 E+02
^{238}Pu	6.2 E+01	1.9 E+04	3.1 E+02	4.4 E+03	7.1 E+01	7.2 E+02	1.2 E+01
^{239}Pu[g]	5.6 E+01	4.5 E+04	8.0 E+02	9.6 E+04	1.7 E+03	4.7 E+03	8.5 E+01
^{241}Pu	2.9 E+03	3.6 E+05	1.2 E+02	2.4 E+05	8.4 E+01	1.9 E+04	6.6 E+00
^{241}Am	5.5 E+01	3.7 E+04	6.7 E+02	1.6 E+05	3.0 E+03	1.2 E+05	2.1 E+03
^{242}Cm	1.7 E+03	f	f	1.0 E-02	5.9 E-06	3.2 E-02	1.9 E-05
^{244}Cm[e]	5.5 E+01	f	f	6.6 E+02	1.2 E+01	6.9 E+02	1.2 E+01
Total sum of fractions			1.0 E+04		5.0 E+03		4.0 E+03

[a]WHC, 1995, *Interim Chapter 3.0 Hazard and Accident Analysis*, WHC-SD-WM-SAR-065, Rev. 0, DRAFT, Westinghouse Hanford Company, Richland, Washington.

[b]Double-shell tanks, excluding the Aging Waste Facility tanks.

[c]Aging Waste Facility tanks (Tank Farms 241-AY and 241-AZ).

[d]Total activity inventory calculated using the maximum sample activity concentration times the waste volume for worst single tank (see Table 1). Total is the sum of the liquid and solid activity inventories.

[e]This isotope is not listed in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis reports*, U.S. Department of Energy, Washington, D.C. All of these are fission products except ^{244}Cm, which is an alpha emitter. DOE-STD-1027-92 recommends a Hazard Category 2 threshold quality of 2.5 E+06 Ci for mixed fission products, and 55 Ci for alpha emitters.

[f]No data available in the Tank Farms ASA (WHC 1995). These radionuclides have a negligible impact on the radiological hazard categorization determination because of their low activity concentrations.

[g]The ^{239}Pu activity concentration also includes ^{240}Pu.

Table 4. Estimated Tank Waste Inventories Based on the Mean Activity Concentrations.[a]

Nuclide	DOE 1027-92 Category 2 threshold quantity (TQ), (Ci)	Single-shell tanks		Double-shell tanks[b]		Aging Waste Facility tanks[c]	
		Total inventory[d] (Ci)	Fraction of Category 2 TQ	Total inventory[d] (Ci)	Fraction of Category 2 TQ	Total inventory[d] (Ci)	Fraction of Category 2 TQ
^{14}C	1.4 E+06	2.1 E+02	1.5 E-04	1.4 E+02	9.9 E-05	2.1 E+01	1.5 E-05
^{60}Co	1.9 E+05	2.3 E+05	1.2 E+00	3.6 E+03	1.9 E-02	1.9 E+04	1.0 E-01
^{79}Se[e]	2.5 E+06	6.0 E+01	2.4 E-05	f	f	f	f
^{90}Sr	2.2 E+04	6.7 E+07	3.0 E+03	2.5 E+06	1.1 E+02	3.1 E+07	1.4 E+03
^{90}Y	2.5 E+06	6.7 E+07	2.7 E+01	2.5 E+06	9.9 E-01	3.1 E+07	1.2 E+01
^{99}Tc	3.8 E+06	5.6 E+06	1.5 E+00	1.1 E+04	2.8 E-03	5.1 E+03	1.3 E-03
^{106}Ru	6.5 E+03	2.5 E+01	3.9 E-03	f	f	f	f
^{125}Sb[e]	2.5 E+06	5.6 E+04	2.2 E-02	f	f	f	f
^{129}I[e]	2.5 E+06	2.8 E+03	1.1 E-03	2.1 E+01	8.5 E-06	2.5 E+01	1.0 E-05
^{134}Cs	6.0 E+04	1.6 E+03	2.6 E-02	6.5 E+03	1.1 E-01	8.4 E+00	1.4 E-04
^{137}Cs	8.9 E+04	2.7 E+07	3.0 E+02	3.1 E+07	3.4 E+02	1.2 E+07	1.4 E+02
^{144}Ce	8.2 E+04	2.1 E+00	2.6 E-05	f	f	f	f
^{147}Pm	8.4 E+05	f	f	1.6 E+04	1.9 E-02	f	f
^{154}Eu	1.1 E+05	5.9 E+05	5.4 E+00	1.3 E+05	1.2 E+00	2.0 E+05	1.8 E+00
^{155}Eu	7.3 E+05	2.7 E+04	3.7 E-02	f	f	f	f
^{237}Np	5.8 E+01	1.1 E+05	1.8 E+03	4.4 E+01	7.6 E-01	8.1 E+03	1.4 E+02
^{238}Pu	6.2 E+01	3.5 E+04	5.7 E+02	2.0 E+03	3.2 E+01	1.4 E+03	2.2 E+01
^{239}Pu[g]	5.6 E+01	8.4 E+04	1.5 E+03	2.5 E+04	4.4 E+02	6.7 E+03	1.2 E+02
^{241}Pu	2.9 E+03	6.7 E+05	2.3 E+02	9.3 E+04	3.2 E+01	4.0 E+04	1.4 E+01
^{241}Am	5.5 E+01	7.0 E+04	1.3 E+03	4.4 E+04	8.0 E+02	1.5 E+05	2.8 E+03
^{242}Cm	1.7 E+03	f	f	1.1 E-01	6.4 E-05	7.5 E-02	4.4 E-05
^{244}Cm[e]	5.5 E+01	f	f	4.3 E+02	7.8 E+00	8.0 E+02	1.5 E+01
Total sum of fractions			8.8 E+03		1.8 E+03		4.6 E+03

[a]Savino, A. V., 1995, *Tank Farm High-Level Waste Compositions and Atmospheric Dispersion Coefficients for Use in ASA Consequence Assessments*, WHC-SD-WM-SARR-016 Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[b]Double-shell tanks, excluding the Aging Waste Facility tanks.

[c]Aging Waste Facility tanks (Tank Farms 241-AY and 241-AZ).

[d]Total activity inventory calculated using the mean activity concentration times the total volume (see Table 1). Total is the sum of the liquid and solid activity inventories.

[e]This isotope is not listed in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.03, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C. All of these are fission products except ^{244}Cm, which is an alpha emitter. DOE-STD-027-92 recommends a Hazard Category 2 threshold quantity of 2.5 E+06 Ci for mixed fission products and 55 Ci for alpha emitters.

[f]No data available in the Tank Farms ASA (WHC, 1995, *Interim Chapter 3.0 Hazard and Accident Analysis*, WHC-SD-WM-SAR-065, Rev. 0, Westinghouse Hanford Company, Richland, Washington). These radionuclides have a negligible impact on the radiological hazard categorization determination because of their low activity concentrations.

[g]The ^{239}Pu activity concentration also includes ^{240}Pu.

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