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Hazards Assessment Document of the New Waste Transfer Facility (NWTF) (U)

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SAVANNAH RIVER SITE

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1.0 Summary

This Hazards Assessment Document for the New Waste Transfer Facility (NWTF) has been prepared in accordance with the *Interim Hazards Classification Guide for Non-Reactor Facilities at Savannah River Site* [1]. The conclusion of this assessment is that the facility is a **High Hazard Nuclear Facility**. The NWTF consists of all facilities installed by Project S-3122 [2]. The NWTF contains three segments. Segment 1 consists of the cells containing the diversion box and pump pits, with a Facility Segment Use Category (FSUC) determined to be High Hazard. Segment 2 is the building that encloses the cells. The FSUC of Segment 2 has been determined to be Low Hazard. Segment 3 consists of all parts of the facility external to the main building; this segment contains the ventilation system and HEPA filters and includes the diesel fuel tank. The FSUC of Segment 3 is Low Hazard.

2.0 Facility Description

The New Waste Transfer Facility (NWTF) provides necessary interfaces between the Defense Waste Processing Facility (DWPF) and existing waste tank farms. The facility will allow the existing HDB-2 diversion box complex to be limited to the service of tanks 9H-12H (waste removal operations). The NWTF is located near the H-Area Tank Farm south of Tank 22.

Four new pump pits, each containing one pump tank, and one new diversion box are provided in five adjacent cells. This facility is enclosed in a building (241-100H) with a remotely operated bridge crane for servicing the equipment and an HP changeout area. The facility will handle transfers between the DWPF and the H-Area Tank Farm, between the F-Area Tank Farm and the H-Area Tank Farm, between the Effluent Treatment Facility (ETF) and the H-Area Tank Farm, and inter-tank transfers within the H-Area Tank Farm.

A ventilation system is provided for pump tanks and pump tank cells. All air discharged from the vessel ventilation and main building ventilation systems will be HEPA filtered. The HEPA filter equipment is housed in a separate concrete shielded building (241-101H). A standby diesel generator and diesel fuel tank are located nearby [2].

3.0 Facility Segments

The NWTF is divided into three Facility Segments. Segment 1 consists of the cells in Building 241-100H containing the diversion box and pump pits. Segment 2 is the building surrounding the cells. Segment 3 consists of Building 241-101H (ventilation system and HEPA filters) and the diesel fuel tank.

4.0 Hazardous Material Inventory

4.1 Facility Segment 1

The following waste streams are expected to pass through the NWTF [3, 10]:

- Fresh High Heat Waste (HHW)
- Fresh Low Heat Waste (LHW)
- HHW and LHW Supernate
- Aged HHW and LHW Sludge Slurries
- Reconstituted Salt
- In-Tank Precipitation (ITP) Wash Water
- Extended Sludge Processing (ESP) Wash Water
- DWPF Late Wash Process Wash Water
- DWPF Recycle Waste
- Receiving Basin for Offsite Fuel/Resin Regeneration Facility (RBOF/RRF) Waste Water

Each stream contains a variety of radionuclides and hazardous chemicals in varying concentrations. The Tank Farm SAR [10] is used as the source of radionuclide content; the SRS Basic Data Report [11] gives specific chemical content.

The inventory of two pump tanks, maximum working capacity of 5,000 gallons each, filled with H-Area HHW is used for the radionuclide analysis (see Table 1). Because the activity/gallon of this waste is higher than any other waste expected to pass through the NWTF, the other streams need not be evaluated.

The hazardous chemicals in this segment of the NWTF are not listed or analyzed in this document because the radiological hazards already place the segment in the High Hazard category (see Section 6).

4.2 Facility Segment 2

Facility Segment 2 is the building covering the pump pit and diversion box cells. It includes the instrument control room, field operating station, crane control room, electrical control room, battery room, vacuum pump room, and storage rooms. The building contains only low levels of contamination. There is no other inventory of radionuclides in this segment.

4.3 Facility Segment 3

Facility Segment 3 contains the ventilation system and the HEPA filters, which remove any airborne radionuclides from the air passing over the pump pits and through the pump tanks and diversion box. Per ALARA agreement between Waste Management and Health Protection, the HEPA filters will be changed out when they emit 250 mR/hr or greater of radiation at 10 cm. The worst case situation is the HEPA filters emitting 500 mR/hr of radiation at 4 to 5 feet [10]. The radionuclide inventory that corresponds to this amount of radiation is given in Table 1.

The only hazardous chemicals in Facility Segment 3 are diesel fuel and ethylene glycol. A 300 gallon tank holds diesel fuel for the diesel generator. Eighty gallons of a 30% solution of ethylene glycol are used in the chiller unit of the process ventilation condenser. Two gallons of a 50% solution of ethylene glycol is used for generator maintenance purposes.

5.0 Nuclear Facility Classification

The New Waste Transfer Facility will regularly transfer and temporarily store radioactive wastes. Therefore, as required by DOE Orders 6430.1A and 5480.5 and the HAD Guide [1], the New Waste Transfer Facility is classified as a **Nuclear Facility**. The facility is subject to the design criteria outlined in Division 13 of DOE Order 6430.1A.

6.0 Hazards Assessment

The major objective of a HAD is to determine the applicable design requirements in DOE Order 6430.1A. To satisfy this objective, the radiological and chemical doses are calculated using extremely conservative methods without considering any engineered systems or administrative controls to mitigate accident consequences. Therefore, the following numerical results should not be used in any other context. Specifically, they should not be confused with the results reported in SARs or JCOs that are determined in a more realistic, but yet conservative manner, with appropriate consideration being given to mitigating systems and administrative controls.

6.1 Facility Segment 1

6.1.1 Radiological Hazard

Both the onsite and offsite radiological doses were calculated using the AXAIR-89Q [5] computer code. The calculations use the following parameters as suggested in the HAD Guide:

- The on-site receptor is located downwind at a distance of 100 meters.
- The off-site receptor is located at the site boundary in the worst meteorological sector.

- The release duration is two hours.
- Site-specific atmospheric dispersion factors are employed from the current meteorological data base (1987-1991).
- All releases are assumed to be at ground level. Building wake effects and plume-terrain interactions are conservatively not considered.
- The ICRP-30 dose factors in AXAIR-89Q are employed.
- Release to the atmosphere is unfiltered.
- Daughter ingrowth is limited to parents with a half-life of less than 24 hours.

Three release scenarios are considered in this Hazards Assessment. The first is a leak in a pump pit cell or the diversion box. In this scenario, radionuclides become airborne through evaporation of the spilled waste. Using a spill of High Heat Waste for analysis, the dose to an onsite individual is less than three rem. The dose to an offsite individual is less than $5E-3$ rem.

The second scenario involves a tetraphenylborate (TPB) fire. Several waste streams, such as ITP wash water and DWPF Late Wash Process wash water contain salts of TPB. This scenario involves a leak during transfer of a stream containing TPB, evaporation of the liquid, and ignition of the combustible TPB salt cake. The consequences of this accident are not calculated because they are bounded by a deflagration in a pump tank (analyzed below). In a deflagration, more waste of higher activity becomes airborne compared to a TPB fire.

The third scenario, the worst case accident, is the result of a hydrogen or benzene deflagration in a pump pit tank. Hydrogen is produced by the radiolytic decomposition of water in High Heat Waste. Benzene and other volatile organics are present in DWPF Recycle Waste and ITP Wash Water. Because the Curie content of H-Area High Heat Waste is significantly higher than the content of all other waste streams expected to pass through the NWTF, it is used as the basis for consequence analysis of a deflagration.

In the analysis of the consequences of a deflagration in a pump tank, the following assumptions are made:

- Two tanks will deflagrate. During normal operations, only one pump tank will be used at a time. Two tanks are chosen for analysis since it is physically possible to use more than one tank at a time.
- At the time of a deflagration, the tanks are at their maximum working capacity of 5,000 gallons each [12].

- A Source Reduction Factor (SRF) of 1.0 is used for tritium, and an SRF of 0.01 is used for all other radionuclides. That is, all the tritium becomes airborne, while only 1% of the other radionuclides becomes airborne in the event of a hydrogen deflagration [6].

The airborne activities of each radionuclide in Table 2 are calculated by multiplying the activities in Table 1 by the above SRFs. These airborne activities are used to calculate the maximum individual doses of 38,000 rem onsite and 57 rem offsite. Based on these doses, this facility segment is classified as High Hazard (onsite dose > 100 rem and offsite dose > 5 rem).

6.1.2 Nuclear Criticality Hazard

Because Facility Segment 1 is classified as High Hazard based on the radiological hazards, a criticality analysis is not necessary [1].

6.1.3 Chemical Hazard

Because Facility Segment 1 is classified as High Hazard based on the radiological hazards, a chemical hazards analysis is not necessary [1].

6.2 Facility Segment 2

6.2.1 Radiological Hazard

Under operating conditions, Facility Segment 2 contains very low levels of contamination, which will be well within the limits for a Low Hazard Nuclear Facility. Therefore, a radiological hazards analysis is not required.

6.2.2 Nuclear Criticality Hazard

There is no criticality hazard present in Segment 2.

6.2.3 Chemical Hazard

Segment 2 does not present any chemical hazards; therefore a chemical hazards analysis is not required.

6.3 Facility Segment 3

6.3.1 Radiological Hazard

Facility Segment 3 contains the ventilation system and HEPA filters. Per ALARA agreement between Waste Management and Health Protection, the HEPA filters will be changed out when they emit 250 mR/hr or greater of radiation at 10 cm. The worst case situation is the HEPA filters emitting 500 mR/hr of radiation at 4 to 5 feet [10]. The maximum content of radionuclides on the HEPA filters based on 500 mR/hr of radiation and the radionuclide content of H-Area HHW is given in Table 1.

The worst case accident that can affect the HEPA filters is a fire. In the event of a fire an SRF of 0.01 [6] is used to calculate the airborne activity of each radionuclide (given in Table 2). This airborne activity results in a dose of 1.6 rem to an onsite individual and $2.4\text{E-}3$ rem to an offsite individual.

6.3.2 Nuclear Criticality Hazard

The small amounts of radionuclides deposited on the HEPA filters do not present a nuclear criticality hazard.

6.3.3 Chemical Hazard

The only hazardous chemical in Facility Segment 3 that will be considered is ethylene glycol. Eighty gallons of a 30% solution of ethylene glycol is used in the chiller unit of the process ventilation condenser. Two gallons of a 50% solution of ethylene glycol is used for maintenance of the facility's backup generator. (The 300 gallons of diesel fuel in this Segment is in a quantity that is routinely accepted by the public. Also, this amount of fuel is exempted from hazards analysis based on the Occupational Safety and Health Standard 1910.119, "Process Safety Management of Highly Hazardous Chemicals" [8]).

A chemical release of ethylene glycol was analyzed with the EPA Open Dump Air Emissions model [7]. The assumptions necessary for this analysis are:

Circular spill 1 cm in depth
Temperature of 40°C

The calculated release rate of 10.4 mg/s multiplied by the onsite and offsite atmospheric dispersion coefficients (χ/Q_s) from AXAIR-89Q yields an airborne concentration of $3.8\text{E-}2$ mg/m³ at 100 meters and $5.66\text{E-}5$ mg/m³ at the site boundary. These concentrations are well below the Emergency Exposure Guidance Level of the National Academy of Sciences value (equivalent to ERPG-2) of 96.3 mg/m³ for ethylene glycol.

7.0 Facility Segment Use Categories

The Facility Segment Use Category was determined by comparing the results of the hazard consequences with the guidelines given in the *Interim Hazards Classification Guide for Non-Reactor Facilities at Savannah River Site*. Table 3 lists the guidelines. The FSUC for Segment 1 is **High Hazard**. The FSUCs for Segments 2 and 3 are **Low Hazard**. Table 4 summarizes the results. To ensure these classifications, failures in Segments 2 and 3 must not propagate to cause additional failures in Segment 1.

8.0 Facility Hazard Class

As defined in the HAD Guide [1], the facility hazard class shall be determined by the highest individual Facility Segment Use Category. Therefore, based on the High Hazard FSUC of Segment 1 of this facility, the overall Facility Hazard Class for the New Waste Transfer Facility is a **High Hazard Nuclear Facility**.

9.0 Safety Class Items

DOE Order 6430.1A (Paragraph 1300-3.2) defines Safety Class Items as the systems, components, and structures, including portions of process systems, whose failure could adversely affect the environment or the safety and health of the public. It gives the following six characteristics of safety class items:

- Those whose failure would produce exposure consequences that would exceed the guidelines in Section 1300-1.4.
- Those required to maintain operating parameters within the safety limits specified in the OSRs during normal operations and anticipated operational occurrences.
- Those required for nuclear criticality safety.
- Those required to monitor the release of radioactive materials to the environment during and after a DBA.
- Those required to achieve and maintain the facility in a safe shutdown condition.
- Those that control the safety class items describe above.

For the NWTF, the maximum offsite radiological consequence of 57 rem is above the maximum acceptable consequence level of 25 rem for Safety Class Items [9]. Therefore, Safety Class Items may be required for the New Waste Transfer Facility.

10.0 References

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2. New Waste Transfer Facility Modifications Functional Design Criteria, G-FDC-H-00020, Westinghouse Savannah River Company, September 13, 1991.
3. Rice, P. J., 'Project S3122, New Waste Transfer Facility Waste Stream Info (U),' Inter-Office Memorandum WER-WMP-92-4612, Westinghouse Savannah River Company, June 5, 1992.

4. Environmental Protection Agency, Code of Federal Regulations, 40 CFR, Chapter 1, Part 302, "Designation, Reportable Quantities, and Notification," July 1, 1991.
5. Huang, J. C., *Use of the AXAIR-89Q Code*, Westinghouse Savannah River Company, WSRC-TR-90-569, December 5, 1990.
6. Elder, J. C., et al, *A Guide to Radiological Accident Considerations for Siting and Design of DOE Nonreactor Nuclear Facilities*, Los Alamos National Laboratory, LA-10294-MS, January 1986.
7. Environmental Protection Agency, *Hazardous Waste Treatment, Storage and Disposal Facilities (TSDF) - Air Emission Models*, EPA-450/3-87-026, December, 1987.
8. Occupational Safety and Health Administration, 29 CFR 1910, "Process Safety Management of Highly Hazardous Chemicals; Explosives and Blasting Agents; Final Rule," February 24, 1991.
9. Donner, E. B., et al, *Methodology for Determination of Safety Class Items for Non-Reactor Nuclear Facilities (U)*, Westinghouse Savannah River Company, WSRC-TR-92-174 (Rev. 1), September 25, 1992.
10. Legler, B. M., et al, *Safety Analysis - 200 Area Savannah River Plant Liquid Radioactive Waste Handling Facilities*, DPSTSA-200-10 Sup-18, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC, August, 1988.
11. *Savannah River Site, Basic Data Report - Material Balance Tables*, DPSP-80-1033, Rev. 138, E. I. du Pont de Nemours & Co., Aiken, SC, January, 1989.
12. *Project S-3122, New Waste Transfer Facility Design Criteria*, A00369, Bechtel National, Inc., San Francisco, May, 1985.

11.0 Tables

Table 1. Radionuclide Inventories

Radionuclide	Segment 1 - Pump Tanks ^a (Ci)	Segment 2 - HEPA Filters ^b (Ci)
H-3	5.0E+01	0
Sr-89	1.9E+04	8.9E-01
Sr-90	1.8E+05	8.5E+00
Y-90	1.8E+05	8.5E+00
Y-91	3.5E+04	1.6E+00
Zr-95	5.7E+04	2.7E+00
Nb-95	1.2E+05	5.6E+00
Ru-106	5.1E+04	2.4E+00
Rh-106	5.1E+04	2.4E+00
Cs-137	9.8E+04	4.6E+00
Ba-137	9.0E+04	4.2E+00
Ce-144	7.3E+05	3.4E+01
Pr-144	7.3E+05	3.4E+01
Pm-147	3.9E+05	1.8E+01
U-235	3.5E-04	1.6E-08
U-238	2.9E-04	1.4E-08
Pu-238	4.7E+03	1.9E-01
Pu-239	3.3E+01	1.6E-03
Pu-241	1.1E+03	5.2E-02
Am-241	6.5E+00	3.1E-04
Cm-244	2.1E-01	9.9E-06
Total	2.7E+06	1.3E+02

^a Activities are based on 10,000 gallons of H-Area High Heat Waste.

^b Activities are based on the HEPA filters emitting 0.5 R/hr of radiation at 5 feet.

Table 2. Airborne Activities

Radionuclide	Segment 1 - Pump Tanks (Ci)	Segment 2 - HEPA Filters (Ci)
H-3	5.0E+01	0
Sr-89	1.9E+02	8.9E-03
Sr-90	1.8E+03	8.5E-02
Y-90	1.8E+03	8.5E-02
Y-91	3.5E+02	1.6E-02
Zr-95	5.7E+02	2.7E-02
Nb-95	1.2E+03	5.6E-02
Ru-106	5.1E+02	2.4E-02
Rh-106	5.1E+02	2.4E-02
Cs-137	9.8E+02	4.6E-02
Ba-137	9.0E+02	4.2E-02
Ce-144	7.3E+03	3.4E-01
Pr-144	7.3E+03	3.4E-01
Pm-147	3.9E+03	1.8E-01
U-235	3.5E-06	1.6E-10
U-238	2.9E-06	1.4E-10
Pu-238	4.7E+01	1.9E-03
Pu-239	3.3E-01	1.6E-05
Pu-241	1.1E+01	5.2E-04
Am-241	6.5E-02	3.1E-06
Cm-244	2.1E-03	9.9E-08
Total	2.7E+04	1.3E+00

Table 3. FSUC Hazard Guidelines

Hazard Type	Consequences		FSUC
	On-Site	Off-Site	
Radioactive	Background	Background	General Use
	< 5 rem	< 0.5 rem	Low Hazard
	5 - 100 rem	0.5 - 5 rem	Moderate Hazard
	> 100 rem	> 5 rem	High Hazard
Chemical	< ERPG-1	< 0.01 IDLH	General Use
	< 0.1 IDLH	< 1 E -06 ICR	General Use
	< 5 E -05 ICR	-	General Use
	> ERPG-1	> 0.01 IDLH	Low Hazard
	> 0.1 IDLH	> 1 E -06 ICR	Low Hazard
	> 5 E -05 ICR		Low Hazard
	> ERPG-2	> ERPG-1	Moderate Hazard
	> 1.0 IDLH	> 0.1 IDLH	Moderate Hazard
	> 5 E -04 ICR	< 5 E -05 ICR	Moderate Hazard
	> ERPG-3	> ERPG-2	High Hazard
	> 5.0 IDLH	> 1.0 IDLH	High Hazard
	> 1 E -02 ICR	> 5 E -04 ICR	High Hazard

Table 4. Hazards Summary

Segment	Hazard Type	Consequences (rem or fraction IDLH)		FSUC	
		Onsite	Offsite	Onsite	Offsite
1	Radiological	38,000	57	High Hazard	High Hazard
	Chemical	N/A	N/A	N/A	N/A
2	Radiological	N/A	N/A	Low Hazard	Low Hazard
	Chemical	N/A	N/A	General Use	General Use
3	Radiological	1.6	2.4E-3	Low Hazard	Low Hazard
	Chemical	3.9E-4*	5.8E-7*	General Use	General Use

* Fraction ERPG-2

ADDENDUM 1: DOE-STD-1027-92 EVALUATION

1.0 Introduction

The purpose of this addendum is to provide additional hazards analysis for the New Waste Transfer Facility (NWTF) in accordance with DOE-STD-1027-92¹. The Hazards Assessment Document and this addendum provide the authorization basis in accordance with DOE Order 5480.21. The initial hazards analysis provided in the Hazards Assessment Document determined that the facility is a High Hazard facility. This classification was based on both the radiological and toxicological evaluations. The evaluation performed in this addendum provides a classification based only on the radiological hazards. The use of this new methodology provides a radiological evaluation that determines that the facility is a Category 2 Facility. The evaluation performed in this addendum does not affect the criteria application of DOE Order 6430.1A which is discussed in Section 5.0 of the Hazards Assessment Document.

To comply with DOE guidance, the hazard classification is based upon comparing facility inventories against threshold quantities of radionuclides as set forth in DOE-STD-1027-92. A summary of this methodology is provided in Section 2 of this addendum. The hazards analysis does not take credit for engineered safety features or administrative controls except for the limit placed on the inventory for this evaluation. Because this methodology of hazard classification is based upon a maximum facility inventory relative to radionuclide quantities, it is not necessary to perform atmospheric dispersion calculations or to determine the most appropriate source release fraction for each likely accident scenario. DOE-STD-1027-92 provides guidance for establishing an inventory limit for a selected list of radionuclides.

2.0 Hazard Classification Methodology

The criteria for determining the hazard classification of the NWTF are provided in DOE-STD-1027-92. In the standard, three hazard categories are defined. A facility is classified as **Hazard Category 1** if the hazards analysis shows the potential for significant offsite consequences, **Hazard Category 2** if the hazards analysis shows the potential for significant onsite consequences, and **Hazard Category 3** if the hazards analysis shows the potential for significant localized consequences only. In this analysis, a facility that does not meet or exceed the Category 3 threshold criteria but still possesses some amount of radioactive material is considered a **Radiological Facility**. The criteria for determining the hazard classification are established as follows:

¹ U. S. Department of Energy, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," DOE-STD-1027-92, December, 1992.

Hazard Category 1

- The facility has the potential for significant offsite consequences based on total curie content, potential material forms, and maximum energy for dispersion available.

Hazard Category 2

- The quantity of any radionuclide exceeds the Category 2 threshold quantity provided in Table A.1 of DOE-STD-1027-92. This quantity is based on 1 rem at 100 meters as determined in 10 CFR 30 and modified by DOE. The threshold quantity for radionuclides not included in the table will be assigned based on footnote 1 of Table A.1.
- The minimum critical mass limit for any fissile material as specified in ANSI 16.1 is exceeded.
- The total of mixed fission products is greater than 1000 curies.
- Where there are combinations of radioactive materials, the sum of the ratios of the quantity of each radionuclide to the Category 2 thresholds exceeds one.

Hazard Category 3

- The quantity of any radionuclide exceeds the Category 3 threshold quantity provided in Table A.1 of DOE-STD-1027-92. This quantity is based on 10 rem at 30 meters based on a 24 hour exposure.
- Where there are combinations of radioactive materials, the sum of the ratios of the quantity of each radionuclide to the Category 3 thresholds exceeds one.

3.0 Inventory

The maximum radionuclide inventory for Segment 1 of the NWTF is provided in Table A-1. Only Segment 1 is analyzed because its inventory is several orders of magnitude higher than the other segments of the NWTF. The radionuclide inventory is calculated by multiplying the curies per gallon of each radionuclide (from Table 4-6 of the Tank Farm SAR²) by the maximum working volume of two pump tanks. The radionuclide inventory for Segment 1 is compared to Category 2 threshold values in Table A-1.

²Legler, B. M., et al, *Safety Analysis - 200 Area Savannah River Plant Liquid Radioactive Waste Handling Facilities*, DPSTSA-200-10 Sup-18, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC, August, 1988.

4.0 Hazard Analysis and Classification

The radiological analysis involved an evaluation of the maximum radionuclide inventory in Segment 1 of the NWTF. In accordance with the methodology of Section 2, the inventory was compared to the threshold limits provided in Table A.1 of DOE-STD-1027-92. As shown in Table A-1, this comparison demonstrated the following:

- The inventory of some of the radionuclides in Segment 1 of the facility was greater than the Hazard Category 2 threshold limit.
- The sum of the ratios of the inventory to the Hazard Category 2 threshold limits was greater than one.

Therefore, this analysis results in this facility being classified as a Category 2 Facility. There is a significant onsite hazard as a result of this radionuclide inventory.

5.0 Summary of Results

The radiological analysis performed in accordance with DOE-STD-1027-92 resulted in this facility being classified as a **Category 2 Facility**. The requirements of DOE Order 5480.23 are applicable to Category 2 Facilities. All other applicable DOE safety requirements must also be satisfied. This analysis was based on the maximum radionuclide inventory expected within Segment 1 of the facility. The addition of inventories from Segments 2 and 3 does not affect this classification.

Table A-1. Segment 1 Radiological Hazards Evaluation

Radionuclide	Inventory (Ci)	Category 2 Threshold (Ci)	Ratio to Category 2 Threshold
H-3	5.0E+01	3.0E+05	1.7E-04
Sr-89	1.9E+04	7.7E+05	2.5E-02
Sr-90	1.8E+05	2.2E+04	8.2E+00
Y-90*	1.8E+05	4.3E+05	4.2E-01
Y-91	3.5E+04	6.5E+05	5.4E-02
Zr-95	5.7E+04	1.5E+06	3.8E-02
Nb-95*	1.2E+05	4.3E+05	2.8E-01
Ru-106	5.1E+04	6.5E+03	7.8E+00
Rh-106*	5.1E+04	4.3E+05	1.2E-01
Cs-137	9.8E+04	8.9E+04	1.1E+00
Ba-137*	9.0E+04	4.3E+05	2.1E-01
Ce-144	7.3E+05	8.2E+04	8.9E+00
Pr-144*	7.3E+05	4.3E+05	1.7E+00
Pm-147	3.9E+05	8.4E+05	4.6E-01
U-235	3.5E-04	1.5E-03	2.3E-01
U-238	2.9E-04	2.4E+02	1.2E-06
Pu-238	4.7E+03	6.2E+01	7.6E+01
Pu-239	3.3E+01	2.8E+01	1.2E+00
Pu-241	1.1E+03	2.9E+03	3.8E-01
Am-241	6.5E+00	5.5E+01	1.2E-01
Cm-244*	2.1E-01	5.5E+01	3.8E-03
Sum of Ratios = 1.1E+02			

* The threshold limits for these radionuclides were not provided in Table A.1 of DOE-STD-1027-92. In accordance with footnote 1 of Table A.1, the alpha emitters were assigned a Category 2 threshold limit of 5.50E+01 Ci and the beta-gamma emitters were assigned a Category 2 threshold limit of 4.30E+05 Ci.

END

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