RADIOLOGICAL CHARACTERIZATION OF HANFORD HLW TANK FARM CORE SAMPLES

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ABSTRACT

This paper presents the results of a radiological characterization analysis of core samples from Hanford HLW. Core samples representative of SST and DST waste were analyzed for radionuclide content, as part of a detailed characterization study of Hanford HLW. The identified radionuclides are grouped according to predominant mode of decay. No significant neutron emitters were identified, while Sr-90 and Cs-137 were deemed of concern due to large beta and beta/gamma activities, respectively.

INTRODUCTION

The high-level waste (HLW) currently stored at the Hanford Reservation originated as a result of fuel reprocessing operations. The reprocessing, carried out since 1943, extracted plutonium and uranium for the nation's defense programs; as a byproduct of the extraction, acidic HLW was generated. The waste, abundant in fission products and transuranics, was of little use, and was temporarily stored at the Reservation. Since no permanent disposal plans existed for the HLW, storage tanks were built to accommodate the increasing volumes of waste.

The Hanford Tank Farm consists of 177 underground storage tanks, containing approximately 461,300 m^3 of HLW (1). The 177 tanks are comprised of 149 older, single shell tanks (SSTs) and 28 newer, double-shell tanks (DSTs). The SSTs, built between 1943 and 1964, are approaching their operating lifetime of 50 years, and, as result of safety concerns, HLW has been transferred from SSTs to DSTs since the 1960's (1).

The operator of the Hanford Reservation, Westinghouse Hanford Company, has been engaged in preliminary studies for the permanent disposal of SST and DST waste since the mid-80's. The studies call for decommissioning the 149 SSTs by 2018, with the SST contents transferred to a permanent HLW repository. In support of those studies, core sampling of the tanks has been underway at Hanford since 1990; the core samples, taken from selected SSTs and DSTs, are meant to provide Westinghouse with additional information on the characteristics of the HLW. This particular study is an extension of the characterization and radiological analyses and was performed at the University of New Mexico (UNM) under Sandia National Laboratories (SNL) Contract No. AB-3372.

ANALYSIS PROCEDURE

One of the major operations involving future Hanford HLW disposal is transportation of the waste from the Hanford tank farm to the ultimate repository (i.e. Yucca Mountain). Due to the highly radioactive nature of the HLW, stringent shielding requirements will have to be placed on the transportation casks; with that in mind, this study was initiated to determine the radiological constituency of the HLW, and delineate the nuclides of concern with respect to radiation dose.

The core sample data was obtained by extraction of samples from two Hanford tanks during 1990 and 1991. Samples were obtained from tank SY-101, a DST of 3,800 m^3 capacity, and tank B-110, an SST of 2,000 m^3 capacity (1). The samples were subjected to laboratory analyses by Westinghouse Hanford Company (WHC) and Batelle-Pacific Northwest Laboratory (BPNL), which indicated that the waste was comprised mostly of water (up to 35%), sodium compounds (25%), and nitrate-nitrite solutions (up to 48%) (1). Significant amounts of radionuclides were also identified in the core samples, comprised primarily of fission products (cesium and strontium) and transuranic elements (plutonium and americium). The radionuclide composition of the samples was of particular concern, due to the potentially large dose rates associated with HLW.

The radiological characterization presented in this paper involved determination of the nuclide composition of the core samples, quantification of the associated specific activities, and delineation of the nuclides with respect to the predominant mode of decay. The initial data was obtained from (2), and consisted of numerous sampling results taken during routine maintenance and evaluation work by the Westinghouse Hanford Co. Separate data for SST and DST waste was analyzed for radionuclide content and specific activity. All encountered nuclides were classified and low, average, and high values of associated specific activity were calculated based on the experimental data. The nuclides were then analyzed for decay modes, and classified as predominantly alpha, beta, gamma, neutron, or mixed beta and gamma decay. The determined composition of SST and DST waste is presented in Table I and II, respectively (3).

For both SST and DST waste, the main contributors to the total activity were found to be Sr-90 and Cs-137. Smaller amounts of Tc-99, Pu-239, Pu-240, and Am-241 were also found; other transuranics, as well as fission products, were present in negligible activities ($< 1.0\ \mu Ci$). In terms of the radiological dose equivalent, the alpha and beta decay of the majority of the constituent nuclides can be neglected. Since no neutron emitters were identified, the majority of the radiation originates from gamma/beta decay of Cs-137 and beta decay of Sr-90. The radionuclide inventory in the SST differed from that of the DST; Cs-137 is about 30 times more abundant in the DST samples, while Sr-90 is approximately 300 times more abundant in SST samples (1). The relative Cs-137 deficiency in the SST samples can be attributed to cesium extraction processes carried out on SST waste in the late 1960's; the abundance of Sr-90 in SST samples (or the lack thereof in DST samples) has not yet been fully understood.

CONCLUSIONS

The preliminary radiological characterization of the Hanford HLW samples indicates that the waste is of very high specific activity, comprised mostly of transuranics and fission products. Two major contributors to the total activity were identified: beta-decaying Sr-90 and beta/gamma-decaying

TABLE I
Tank B-110 SST Samples Radionuclide Composition

CONSTITUENT	Low Value	High Value	Average Value	Units
Predominantly Alpha Decay				
Np-237	0.006	0.03	0.01	μCi/g
Pu-238	0.2	0.24	0.22	μCi/g
Pu-239/40	5.78	6.97	6.52	μCi/g
Am-241	7.92	8.43	8.20	μCi/g
Cm-243/44	0.005	0.2	0.1	μCi/g
Predominantly Beta Decay				
Tc-99	1.17	1.31	1.25	μCi/g
I-129	0.0008	0.002	0.001	μCi/g
Sr-90	11.38	14.14	13.03	mCi/g
Predominantly Gamma Decay				
Co-60	0.0054	0.012	0.0081	μCi/g
Predominantly Neutron Decay				
- No Recorded Predominant Neutron Emitters -				
Beta and Gamma Decay				
Cs-137	14.38	15.03	14.57	μCi/g

TABLE II
Tank SY-101 DST Samples Radionuclide Composition

CONSTITUENT	Low Value	High Value	Average Value	Units
Predominantly Alpha Decay				
Np-237	< 0.1	< 0.7	< 0.45	μCi/g
Pu-239/40	0.095	0.028	0.017	μCi/g
Am-241	0.1015	0.228	0.156	μCi/g
Predominantly Beta Decay				
I-129	< 0.01	< 1.6	< 0.30	μCi/g
Tc-99	0.0002	0.86	0.37	μCi/g
Sr-90	20.9	71.2	33.5	μCi/g
Predominantly Gamma Decay				
- No Recorded Predominant Gamma Emitters -				
Predominantly Neutron Decay				
- No Recorded Predominant Neutron Emitters -				
Beta and Gamma Decay				
Cs-137	310	955	411.0	μCi/g

Cs-137. No significant neutron emitters were identified in the samples, so it was concluded that beta and gamma radiation would be of greatest concern for an unshielded source. For transportation operations, the major emphasis should be placed on reducing the gamma radiation component.

REFERENCES

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