Introduction and Summary

Drum #BC-0148 was generated as a result of a shipping cask sabotage test performed by Battelle Columbus in 1983. This sabotage test was conducted with radioactive materials generated in a pilot scale test facility used to produce materials to use in the test. The test materials were produced to simulate a shipping cask loaded with vitrified High Level Waste (HLW), but in fact, the test materials were not high level waste, but test specimens created in a laboratory specifically for the test. The laboratory test facility was not a reprocessing facility and did not conduct reprocessing for the purpose of recovering uranium or plutonium. HLW is waste resulting from reprocessing, therefore, the waste generated in these tests are not HLW. Once the test was conducted the test specimens were determined to be discarded as waste and would then be required to be classified as to the type of waste based on the wastes' characteristics. Since the test specimens contain greater than 100 nanocuries per gram of transuranic (TRU) isotopes, the resulting waste from this test is considered to be transuranic waste.

Background

In 2005 DOE Headquarters the Ohio and Savannah River Field Offices, through negotiations with SCDHEC, reached agreement for shipment of TRU waste from Battelle Columbus to the Savannah River Site. A formal Memorandum of Agreement was signed between DOE-SR and SCDHEC. This agreement required removal of the Battelle Columbus TRU from SRS by January 1, 2009. The shipments to SRS have been completed and the drums are stored in E-Area.

During a review of the records by WGI-TRU Solutions to support the acceptable knowledge certification, which included investigation reports and videos of packaging, it has been determined that the waste material Drum #BC-0148 was generated as a result of a shipping cask sabotage test performed by Battelle Columbus in 1983. Specifically, the "High Level Waste Sabotage Source Term Investigation Report" which describes the investigation that generated this waste, states there were two “HLW” sabotage tests, one "cold test" using simulated HLW and one "hot test" using what is described in the Report as actual “vitrified HLW”, but in fact, the test material upon discard as waste does not meet the definition of HLW. The objective of the investigation was to experimentally characterize the radiological source term resulting from a shaped charge attack on a shipping cask loaded with “vitrified HLW” of the type proposed for use in Germany. The "shot blocks" seen in the packaging video are model casks containing stainless steel cylinders filled with vitrified material relatively high in radioactivity to simulate a “HLW” canister. There were a total of eight small scale canisters produced each containing 475 grams of vitrified radioactive test material. The report for the "hot test" states liquid “HLW” was used to produce the vitrified high activity test specimens but does not identify the source of the liquid. The principle investigator was contacted in an effort to determine the origin of the liquid. The investigator believed that samples

came from the Battelle Pacific Northwest Laboratory (Battelle-PNL) located on the Hanford site. Because the test was to be based on vitrified waste produced from commercial nuclear fuel, it is assumed the samples came from a Battelle-PNL small scale test processing/vitrification demonstration project operated in the late 1970's. This test project processed relatively small experimental quantities of irradiated commercial fuel to make a simulated HLW which in turn was used as feed for a test pilot scale vitrification system. It is believed that samples from the test demonstration were shipped to Battelle-Columbus for the purposes of making simulated glass material that was poured into the cylinders (small scale canisters) seen in the packaging video.

DOE-Carlsbad has notified DOE-SR and DOE-HQ of the results of this investigation and has stated the drum cannot be disposed at WIPP. This conclusion was based on their determination that the high activity waste was high level waste and not transuranic waste as reported. The analysis presented in this paper results in the conclusion that the waste from this test is properly classified as TRU waste.

Discussion

The liquid material produced at Battelle-PNL which was subsequently used to produce the glass material tested in the sabotage test was generated as test specimens produced in a small scale pilot plant in order to demonstrate the viability of vitrification technology. The project utilized six fuel assemblies from a commercial reactor for the demonstration. In general, a conventional Purex-type liquid-liquid extraction process was used for fission-product removal so the test liquid generated would be typical of the nitric - acid, fission – product waste stream from the first extraction cycle of a commercial plant. Uranium and non-radioactive chemicals, normally added to the waste stream by back-cycling of waste from second and third solvent extraction cycles, were added to the dilute liquid to produce a test specimen composition typical (but lower in concentration) of the HLW from a commercial plant. The liquid test specimen was then concentrated ten fold to simulate HLW and provide feed for the spray calciner/in-can melting test process. The pilot test facility then produced two small scale test specimen canisters of vitrified material. In addition, a small quantity of plutonium and uranium was recovered as a by-product which was processed for safe storage and/or disposal, but not for the purpose of producing power or weapons plutonium.

Historically, chemical separation or "reprocessing" technologies have been used to separate plutonium and uranium in irradiated nuclear fuel from fission products. The main purpose of the “reprocessing” was to recover plutonium and uranium in production quantities for the production of power or plutonium. The Battelle-PNL pilot scale facility was specifically designed and constructed to produce a limited amount of high activity test material form similar to HLW for the production and testing of simulated vitrified glass. Therefore the laboratory facility used a chemical separations process to produce a high activity liquid test specimen for testing and was not a reprocessing facility. 10 CFR 50 Appendix F refers to HLW as being "... those aqueous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the

concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuels".

DOE Manual 435.1-1 Radioactive Waste Management Implementation Guide, Page II-5 states:

“reprocessing is considered by the Department to be those actions necessary to separate fissile elements (U-235, Pu-239, U-233, and Pu-241) and/or transuranium elements (e.g., Np, Pu, Am, Cm, Bk) from other materials (e.g., fission products, activated metals, cladding) contained in spent nuclear fuel for the purposes of recovering desired materials”. Given the historical mission of the Department of Energy and its predecessors, desired materials are understood to be fissionable materials.

Further, DOE Manual 435.1-1 Radioactive Waste Management, Definitions, p.6, Item 44 defines Spent Nuclear Fuel (SNF) as:

“fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. Test specimens of fissionable material irradiated for research and development only, and not production of power or plutonium, may be classified as waste, and managed in accordance with the requirements of this Order…”.

The SNF material described above was shipped to Battelle-PNL as irradiated test specimens for research and development. The subsequent tests were conducted also for research and development and the resulting wastes from the tests did not result from reprocessing of SNF, but were the result of the preparation of a test specimen.

As a result, the vitrified test specimen used in the sabotage test should not be classified as High Level Waste (HLW) since the definition of HLW from DOE Manual 435.1-1, Chapter II.A, p.II-1 is: High-level waste is the highly radioactive waste material resulting from the *reprocessing* of spent nuclear fuel, including liquid waste produced directly in reprocessing. The vitrified test specimens did not result from the *reprocessing* of spent fuel as stated above; rather the materials were the result of the preparation of test specimens.

Conclusion

A small quantity of irradiated commercial fuel assemblies were shipped to Battelle-PNL as test specimens for research/development and therefore no longer considered spent nuclear fuel. The Battelle-PNL test facility utilized a chemical separation process in a one time use test facility which was designed to produce a high activity liquid that was further enhanced to produce a test specimen. The test specimen simulated the radiological and chemical properties of HLW that would have resulted from the reprocessing of spent nuclear fuel for testing purposes, but it was not HLW. In general, chemical separation is one of the steps in spent fuel reprocessing however, DOE Order 435.1 specifically defines reprocessing as a process for recovering a desired material

which historically has been fissionable isotopes (i.e. U-235 or Pu-239). The preparation of high activity liquid test specimens (using traditional chemical separation as part of the preparation step) in a test facility is clearly not reprocessing for the purpose of recovering desired materials such as U-235 or Pu-239. Therefore the high activity liquid test specimen that was used to produce the simulated glass for the cask sabotage test was not high level waste as defined in DOE Order 435.1. Based on the characterization and information available this waste contains transuranic isotopes in concentrations greater than 100 nanocuries per gram and, therefore, is properly classified as TRU waste.