SAVANNAH RIVER SITE'S MACROENCAPSULATION PROCESSING OF LESS THAN 3700 BQ/GM1 TRU ISOTOPIC MIXED WASTE FOR DISPOSAL AT THE NEVADA TEST SITE

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ABSTRACT

During the Fiscal Year of 2006 (FY2006) the Savannah River Site (SRS) made a commitment with the South Carolina Department of Health and Environmental Control (SC-DHEC) to remove 1000 cubic meters of Transuranic (TRU) waste from its TRU inventory. As SRS has been generating TRU waste for many years, there was a multi-thousand drum inventory of waste designated as TRU waste. After characterization, a large inventory of TRU designated waste was determined to have a TRU radiological content of less than 3700 Becquerels per gram. This created an inventory of containers that could not be shipped to the Waste Isolation Pilot Plant (WIPP) due to being below the TRU waste threshold. A substantial portion of this debris waste was also known to contain RCRA constituents, making the waste Mixed Low Level Waste (MLLW). In order to safely and economically dispose of this waste inventory the SRS developed a process to characterize, inspect, and repackage this MLLW for disposal at the Nevada Test Site (NTS).

Introduction

Transuranic waste management provides one of the highest business risks for the Savannah River Site with outyear lifecycle contingency valued at $545 Million. Accelerated successful disposition of these wastes mitigates both internal and external program risks. Additionally, during the Fiscal Year 2006 SRS made a commitment with the SC-DHEC to remove 1000 cubic meters of Transuranic (TRU) waste from its TRU inventory. During this time over 650 m3 of TRU waste was re-characterized to Low Level Waste (LLW) and MLLW using Non-Destructive Assay (NDA), NDE, and remediation.

Previously the re-characterized MLLW below the TRU threshold had been dispositioned at WIPP utilizing Ten Drum Overpacks (TDOP) wherein the entire TDOP was characterized as TRU waste acceptable for disposal at WIPP. During FY2006 the Department of Energy (DOE) determined that this "load management", which included an inventory of drums with less than 3700 Bq/gm drums, could no longer be permitted for shipment and disposal at WIPP.

In order to prevent the creation of a waste stream with no path for disposal, SRS decided to prepare and certify this waste for disposal at the NTS. This required SRS to fully characterize, procure an acceptable packaging, repackage, and certify for shipment these wastes prior to the end of Fiscal Year 2006.

Disposal Options

Savannah River Site had only three viable options for the disposal of MLLW debris. The Nevada Test Site, the Energy Solutions facility at Clive, Utah, and the WIPP facility located in Carlsbad, New Mexico.

WIPP Waste Acceptance Criteria (WAC) mandates the waste be Transuranic, containing greater then 3700 Bq/gm of transuranic radionuclides. As mentioned earlier the candidate set of containers identified were all below this radiological threshold and were not in compliance with the WIPP WAC.

Energy Solutions' Clive disposal site's license limits disposal to Nuclear Regulatory Commission Class A material which limits transuranic radionuclides to less than 370 Bq/gm. In the case of the identified candidate drums the vast majority exceeded the Class A limits and thus the Clive facility was not a viable option for disposal of these wastes.

During December 2005, the Nevada Test Site (NTS) was approved for disposal of Mixed Low Level Waste that met Land Disposal Restrictions (LDR). This opened an avenue for SRS to dispose of MLLW debris. It was determined that disposal at the NTS of the MLLW inventory was the most cost effective and practical disposal solution available.

Process

Several hurdles had to be overcome in order to successfully ship this MLLW to the NTS. The first hurdle was to determine the best method to meet LDR for this waste form. As the waste form met the 40 CFR definition of debris waste this inventory was determined to be waste amenable to Macroencapsulation in order to meet LDR treatment standards. Macroencapsulation of MLLW debris had not been attempted by the Savannah River Site before and SRS needed to determine the best avenue to proceed with this option.

The procedurally controlled process began with an engineering review of all pertinent documentation for the candidate waste containers to verify radionuclide content and identification of any potentially prohibited items. NTS and WIPP have slightly differing prohibited items identified with NTS being slightly more restrictive. RCRA constituents also had to be identified to ensure that the treatment standard was appropriate and permissible per the NTSWAC.

Certification of MLLW debris for macroencapsulation had not been attempted previously by SRS and required support by engineering, operations, transportation services, and radiological controls groups in order to be successful. Regulatory obstacles also stood in

the way of processing as the location selected for the Macroencapsulation work was not permitted for RCRA treatment operations.

The final step in obtaining success was to set up a safe and efficient treatment operation. As contamination was of the highest concern several layers of protection were put in place to protect the operators and the facility from contamination with the MLLW.

Radiological Characterization Approach and Issues

For radiological characterization, SRS utilized the basic process that generates WIPP certification data. Utilizing an IQ-3 Canberra detection process, an inventory for each drum was developed from a given radiological library for the known waste stream. This data, provided by the WIPP certified process located on the Savannah River Site in conjunction with certified Low Level Waste streams from the same facilities was broken down by waste stream which typically followed facility boundaries. Utilizing this data allowed the construction of a complete radiological inventory for each container by scaling the known radiological distribution for the waste stream off the selected primary radionuclide determined by the WIPP characterization process. By using an in place and highly reliable source for radiological characterization SRS was able to ensure the NTS that the MLLW sent for disposal did not exceed the TRU waste threshold and was accurately characterized.

To further explain the scaling of radionuclides utilized by SRS in this process the following example is given:

> Given a drum of MLLW the WIPP Non-Destructive Assay Process (NDA) provides data showing the Pu-238 content of the drum to be 5.0 E-06 grams (3.168 E+06 Bq). Net waste weight of the drum is 63 Kilograms (kgs). Assume that historical knowledge shows the Pu-238 isotope to be 50% of the total radioactive content, then it can be determined that the total radionuclide content of the drum is 6.336 E+06 Bq. Scaling provides the remaining isotopic distribution:

Isotope	%Distribution	Isotopic Content
Pu-238	50%	3.168 E+06 Bq
Pu-239	10%	6.336 E+05 Bq
Am-241	10%	6.336 E+05 Bq
Co-60	30%	1.901 E+06 Bq

> Given the known transuranic content the total Bq/gm can be determined to ensure that the waste is below the TRU waste threshold:

$$\frac{4.435\ \text{E+06 Bq TRU Isotopes}}{63{,}000\ \text{grams}}$$

Gives a TRU content of 70.39 Bq/gm well below the threshold of 3700 Bq/gm.

Specific issues related to uncertainty required resolution between SRS and NTS. NTS reviewed the qualifications and certifications of the WIPP certified data and determined that isotopic data provided by a WIPP certified process could be used without the inclusion of any data error. All other data would require the addition of the appropriate error.

RCRA Chemical Characterization Approach and Issues

Each of the proposed waste streams had an Acceptable Knowledge Report. The Acceptable Knowledge Report is a required document for WIPP disposal that details the facility and the processes that constitute the generation of the wastes. These Acceptable Knowledge Reports provided a bounding inventory of RCRA chemicals present in the NTS candidate waste streams. Reporting of RCRA constituents to NTS was as reported in the Acceptable Knowledge Report. For thorough reporting a copy of each Acceptable Knowledge Report was provided to NTS at the time of Waste Profile submittal.

Special Regulatory Agreements

Having determined that the candidate waste streams met the definition of debris waste and all RCRA constituents all were amenable to macroencapsulation, the decision was made to perform the macroencapsulation at the Savannah River Site in one of the Low Level Waste disposal vaults previously modified with a containment system designed for handling of LLW. As the Low Level waste vaults were not permitted for disposal or treatment of MLLW a temporary authorization (TA) was requested from the SC-DHEC. The SRS Environmental Compliance group worked closely with SC-DHEC and developed a set of actions for SRS to take in order to prepare for the macroencapsulation work and also to close out the work area at the end of the processing.

Prior to beginning work, SRS performed a one hundred percent radiological survey of the areas to be involved in the Macroencapsulation process. This allowed for a comparison with a post processing survey to ensure that no residual contamination from the macroencapsulation work was ensuring that no RCRA contaminants were left behind.

Waste Macroencapsulation Containers

For this process SRS determined that a stainless steel macroencapsulation box was the most efficient and cost effective alternative for the macroencapsulation process. For handling and disposal a nominal ninety cubic foot container was selected. Proposals were received from several container manufacturers with one selected. The selected container is a ninety two cubic foot container with a flat top welded closure. Fifty of the containers were ordered. SRS personnel visited the manufacturer several times during

the construction of the containers to ensure the containers met SRS standards. The containers were delivered as ordered and ahead of schedule.

Waste Processing and Treatment

Prior to processing any waste SRS obtained the approval of both SC-DHEC and the NTS. The first step in the processing was the mining and staging of the candidate drums. As mentioned earlier, all drums had been screened by engineering for prohibited items and for compliance with the waste profile as approved by the NTS. The processing occurred in a double containment facility that allowed for staging of materials and for a closed work environment. All workers were suited in full body supplied air plastic suits for contamination protection.

Prohibited items were of particular concern as many of the candidate drums were over twenty years old and the condition of the internal plastic bags was unknown. The first step in identifying prohibited items came during the radiological characterization process. Each drum's NDA report also included a Real Time Radiography (RTR) report. From the RTR report SRS was able to identify prohibited material in the debris waste stream such as absorbed liquids, lead solids, and free liquids. Any container found to have prohibited materials was removed from the candidate container listing. Additionally, all wastes introduced into the macroencapsulation process were visually inspected at the time of repackaging as described below.

Each stainless steel macroencapsulation container was inspected for cleanliness and damage. A fire blanket was draped over the edges of the box for protection of the inner materials during the closure welding. A twelve mil thick plastic bag was fitted into the box, the bag draped over the box to floor level to provide contamination control. Drums were staging in the work area and opened one at a time. Radiological Controls personnel constantly monitored the drum exterior and interior for contamination along with constant air monitoring. The waste was removed from the drum, inspected for prohibited items and loaded into the macroencapsulation container. On average twenty one drums of waste were placed into each macroencapsulation container. It was imperative that all the macroencapsulation containers were filled to greater than ninety percent full per RCRA regulations. All work was overseen by a Waste Certification Official (WCO) or Package Certifier (PC) of the SRS NTS waste program. After it was determined that the macroencapsulation container was filled to the maximum extent, the WCO or PC signed off that the container was full. The plastic bag liner was then closed with a "J" seal and the fire blanket was draped over the filled plastic waste bag.

The empty drums were surveyed and disposed as LLW at the SRS. The Macroencapsulation containers were later seal welded by site construction forces and prepared for shipment to the NTS just prior to shipment to NTS.

Waste Issues

SRS did incur one issue with the repackaging and macroencapsulation that could have prevented successful disposal of the MLLW at NTS. Several weeks after repackaging, and prior to welded closure, SRS reopened one of the macroencapsulation boxes for inspection purposes. The waste had settled to below the regulatory limit of 90% full. Although not unexpected, the degree to which the waste had settled was problematic. SRS conferred with NTS and determined that the use of a filler material would be acceptable to return the waste level to greater than ninety percent full. Pictures were taken throughout the process to ensure to any regulator that the macroencapsulation containers were greater than ninety percent full when closed. All containers were opened and all had settled. The SRS in conjunction with NTS and the Nevada Department of Environmental Protection developed a protocol for the settling issue that is now available on the NTS website.

Conclusion

SRS has found this process to be an effective tool for managing the MLLW waste stream, and was the one of the first sites in the complex to use NTS for mixed waste disposal. Thus far SRS has repackaged in excess of 500 drums and made four successful shipments of MLLW to the NTS. The future for this operation is being studied with a possible second campaign to begin in the late spring of 2007. If you have any questions please contact Glenn Siry at the Savannah River Site, (803) 557-6383. SRS will be more than happy to discuss any aspect of our process, help you with any questions you may have concerning our successful project.