Macroencapsulation of Mixed Low-Level Radioactive Waste at the Nevada Test Site – Current Capabilities – 10268

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ABSTRACT

In an effort to provide cost-effective treatment for mixed low-level radioactive waste (MLLW) generated at the Nevada Test Site (NTS), National Security Technologies, LLC (NSTec), with concurrence from the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NSO), submitted a Generator Treatment Plan to the State of Nevada Division of Environmental Protection (NDEP) for approval. *Resource Conservation and Recovery Act* (RCRA) regulations allow for the treatment of newly generated waste without a RCRA treatment permit with certain restrictions. NDEP approved the NSTec Generator Treatment Plan for the macroencapsulation of MLLW debris-type waste, allowing for the treatment described in this paper to commence.

Approximately 90 percent of the MLLW generated at the NTS is debris waste, resulting in a significant cost-savings versus sending the waste off-site for treatment and returning to the NTS for disposal.

INTRODUCTION

NSTec is performing generator treatment of MLLW debris using high-density/linear low-density polyethylene macro-liners housed within NTS Waste Acceptance Criteria (NTSWAC) compliant packages. The treatment process was approved by NDEP on November 1, 2007, as an acceptable alternative treatment standard for radioactive leads solids. The process is also an accepted alternative treatment standard for hazardous debris by the U.S. Environmental Protection Agency (EPA). The process will be performed on the Area 5 transuranic (TRU) waste storage pad/TRU Pad Cover Building to prepare acceptable containers of MLLW debris for disposal in the permitted Mixed Waste Disposal Unit (MWDU) at the NTS.

Authorization to perform generator treatment of NTS newly generated MLLW is granted for a period not to exceed five years from the date of approval. In addition, it is understood that treatment may only be performed on MLLW that is generated at the NTS. Under this treatment plan, treatment of off-site waste is strictly prohibited.

NDEP and NSO entered into a Settlement Agreement that provided NSO authorization to store, characterize, and certify TRU waste for disposition to an appropriate permitted disposal facility. NSO, in accordance with the Settlement Agreement, operates the Area 5 TRU waste storage pad under the requirements of 40 *Code of Federal Regulations* (CFR) 265 Subpart I. Section B.4 of the Agreement authorizes NSO to perform steps appropriate for waste certification, such as

treatment, if necessary. NSO intends to perform treatment as allowed under Section B.4 so MLLW can be certified for disposal at the NTS.

Characterization and certification of this TRU waste inventory for disposal to the Waste Isolation Pilot Plant (WIPP) in New Mexico resulted in a portion of the TRU waste inventory being identified as MLLW. The waste is not categorized as TRU (i.e., alpha-emitting radionuclides with an atomic number greater than 92, half-life greater than 20 years, in concentrations greater than 100 nanocuries per gram [nCi/g]) and may be treated to comply with the NTSWAC, meet RCRA Land Disposal Restrictions, and be disposed in the permitted MWDU at the NTS.

The MLLW was characterized using non-destructive assay, real-time radiography, and acceptable knowledge (AK). The characterized waste will be treated and packaged to meet the NTSWAC. Each waste stream requires a pre-treatment notification and waste profile to be submitted and approved in accordance with the NTSWAC.

NSO in accordance with the Mutual Consent Agreement (MCA) utilizes the existing TRU waste storage pad as the designated facility to store and manage all mixed wastes generated by NSO within the State of Nevada from operational, characterization, and remediation activities. This designated facility is managed in conformance with applicable RCRA requirements.

In the MCA, NDEP authorized NSO to store newly identified mixed wastes, which have not been identified in the Site Treatment Plan, generated from environmental restoration activities, including characterization and remediation, on the TRU waste storage pad.

The generator treatment plan addresses legacy mixed waste debris from the TRU project, Rocky Flats beryllium debris, and newly generated MLLW debris that is or will be stored on the TRU waste storage pad.

RCRA regulations do not require a Waste Analysis Plan for treatment of hazardous debris under alternative treatment standards of 40 CFR 268.45, Table 1. Therefore, generator treatment using macroencapsulation is not subject to waste analysis plan requirements of 40 CFR 268.7(a)(5).

This document addresses treatment of MLLW debris that carries one or more of the following hazardous waste codes: D004, D005, D006, D007, D008, D009, D010, D011, D019, D022, D027, D028, D029, D040, F001, F002, F003, F004, F005.

WASTE STREAM DESCRIPTIONS

MLLW debris is generated from various activities on the NTS. In accordance with the NTSWAC, treatment of these waste streams is required to meet Land Disposal Restrictions identified in the 40 CFR 268 prior to disposal in the permitted MWDU at the NTS. Waste streams that conform to the definition of debris (minimum particle size of 60 millimeters) may be macroencapsulated meeting the alternative treatment standard for hazardous debris. Treatment of waste categories #1 and #2 listed below has been completed. The only waste

stream currently undergoing treatment that will continue as generated is waste category #3 listed below.

#1 – Legacy MLLW Debris

This legacy debris waste was generated at Lawrence Livermore National Laboratory (LLNL) during research and development (R&D) for nuclear weapons fabrication and materials research. The waste was originally generated at LLNL and shipped to the NTS during the early 1980s. LLNL generated the waste from various R&D activities including diagnostic testing related to underground testing of nuclear devices, research on the behavior of actinide elements, plutonium metallurgy, and other chemical and physical testing, fabrication of plutonium parts, and waste processing.

The waste is currently stored in non-standard sized boxes on the TRU waste storage pad located inside the NTS Area 5 Radioactive Waste Management Complex (RWMC).

Based on information documented in the *Central Characterization Project Acceptable Knowledge Summary Report for Nevada Test Site Lawrence Livermore Laboratory Waste*, Revision 9 (November 2005), and real-time radiography performed on these boxes, the composition of the waste is gloveboxes, metal parts, mechanical equipment, pipes, filters, combustible material (i.e., laboratory trash), insulation material, and lead solids.

The following EPA waste codes are applied to this waste stream: D004, D005, D006, D007, D008, D009, D010, D011, D019, D022, D027, D028, D029, D040, F001, F002, F003, F004, F005.

TRU waste shipped to the NTS from the LLNL through the early 1980s was transported in 58 non-standard waste boxes. Twenty-six boxes are characterized as TRU waste and will be processed for disposal to WIPP.

Nine of the boxes currently assay as MLLW with a radioactive composition of less than 100 nCi/g. The approximate waste volume is 21 cubic meters (730 cubic feet). These boxes will be macroencapsulated as is or, if necessary, opened and processed to meet the requirements of the NTSWAC. Following processing, the remaining MLLW may be treated by macroencapsulation and processed for disposal.

Twenty-three boxes of TRU waste currently assay at greater than 100 nCi/g and less than 400 nCi/g. These boxes will be opened; TRU waste will be segregated from any MLLW. Following segregation, the debris characterized as MLLW will be treated by macroencapsulation and processed for disposal at the NTS. Waste volumes will be identified in the waste profile when submitted for approval.

#2 – Rocky Flats - Beryllium Debris

This legacy waste stream is comprised of beryllium metal debris. This waste stream is MLLW assigned EPA hazardous waste number D007 (chromium) and F002 (1,1,1-trichloroethene).

Rocky Flats Environmental Technology Site (formerly Rocky Flats Plant), generated the debris. Operations included assembly, cleaning, etching, machining, and briquetting of plutonium and other metal parts.

The waste stream is comprised of beryllium metal debris, some of which is coated with a thin layer of chromium metal. Approximately 10 percent of the beryllium may be coated with chromium. Based on process knowledge it is estimated the chromium coating contributes 4 percent to the total waste stream mass.

There are 32 drums of metal debris. Three drums of this waste stream are TRU. The TRU waste may be processed resulting in a portion of the waste being characterized as MLLW. Any resulting MLLW debris will be treated by macroencapsulation and processed for disposal.

Twenty-nine drums of MLLW debris will be treated by macroencapsulation to meet the NTSWAC. The net volume of these 29 drums (before treatment) is approximately 5.1 cubic meters (178.9 cubic feet).

#3 – Newly Generated MLLW Debris

This stream includes waste generated from environmental restoration activities (e.g., characterization, remediation, demolition) across the NTS.

Waste stream composition includes debris (e.g., concrete, metal, wood, paper, non-liquid building demolition debris); discarded materials and equipment (e.g., radiological detectors containing internal check sources less than 100 microcuries, filters); radioactive lead solids; and solidified sludge and soil (potentially containing total petroleum hydrocarbons [TPH] in excess of 100 milligrams per kilogram). Non-debris waste may be commingled with debris but must be volumetrically less than 49 percent in any individual waste package and must be representative of the mixture as found at the excavation site.

Adherence to these criteria is maintained via NSTec's NTS-approved program. This program requires 100 percent waste inspection during packaging. A qualified waste inspector is present during the packaging to verify the waste form meets the definition of debris. In addition, an independent verification is performed by the Waste Certification Official prior to final waste certification. The mixed waste verification process performed by the Radioactive Waste Acceptance Program also provides assurance that the final waste form was treated appropriately to meet Land Disposal Restrictions.

Any MLLW waste destined for macroencapsulation on-site is required to be treated within one year from the date of generation. The procedure involving waste management on the TRU waste

pad under the MCA requires that treatment will be performed within one year from the date of generation for any MLLW that is placed under the MCA where on-site macroencapsulation is the prescribed treatment. The procedure allows up to one year from the time the waste was placed on the TRU waste pad under the MCA for wastes destined for off-site treatment.

One or more of the following EPA waste codes may apply to this waste stream: D004, D005, D006, D007, D008, D009, D010, D011, D019, D022, D027, D028, D029, D040, F001, F002, F003, F004, F005.

MACROENCAPSULATION SYSTEMS

NSO utilizes the UltraTech International (UltraTech) macroencapsulation macro-liner systems (macro-liner), which are comprised of high-density/linear low-density polyethylene (PE) macro-liners housed within NTSWAC-compliant packages. Macro-liners will be customized to fit into standard-sized containers or custom-sized containers manufactured to contain the non-standard boxes.

UltraTech macro-liners are inserted inside the NTSWAC-compliant containers in one of two fashions. Typically for drums, UltraTech uses the cast-in-place process to insert the liner directly into the drum. In this case, the drum itself functions as part of the roto-molding process to cast the liner in place. The box liners are cast in standalone molds and are inserted into the NTSWAC-compliant box. In either case, even though the liners are in direct contact with the NTSWAC-compliant package, they are a structural component of the package. Figure 1 shows an example of a box liner and lid prior to placement within a box. Figure 2 shows the liner inserted in the box.

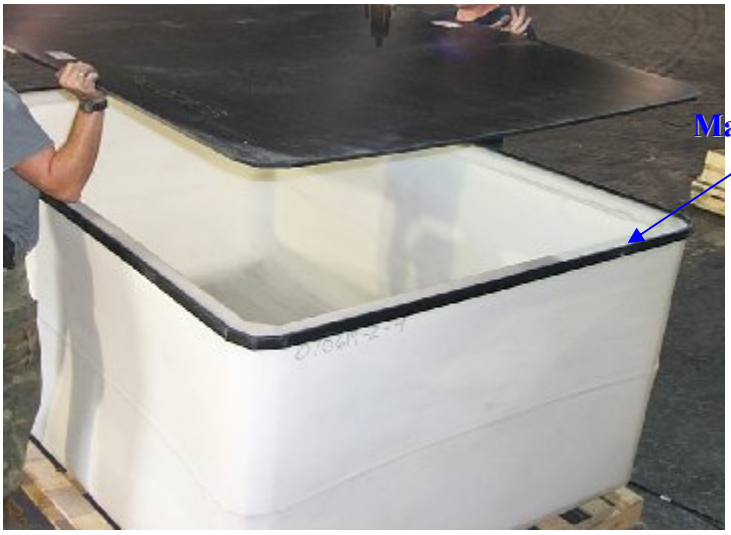

Fig. 1. UltraTech box liner and lid.

Fig. 2. UltraTech box liner positioned in NTSWAC-compliant box.

The macroencapsulation process typically consists of the following steps: The waste (either directly loaded or containerized in a drum or box) is placed into the UltraTech PE macro-liner, and an inert filler material (such as foam or vermiculite) is placed in the liner to eliminate all void space within the macro liner (Figure 3). Once filled, the PE macro lid is put in place and bonded to the PE liner body using a patented bonding process (Figure 4), which yields a half-inch thick (nominally), highly durable, completely sealed PE liner. At this point, the waste is now totally isolated and protected from the environment and any potential leaching media by the half-inch thick, chemically inert, PE jacket. The waste is further protected from any leachates by the inert filler material, which can also act as a protective coating material[1].

Once verified that the macroencapsulation bonding process has been successfully completed, the drum or box lid is put in place and bolted closed, which further protects the waste from the environment.

Fig. 3. Foam being added to fill void[2].

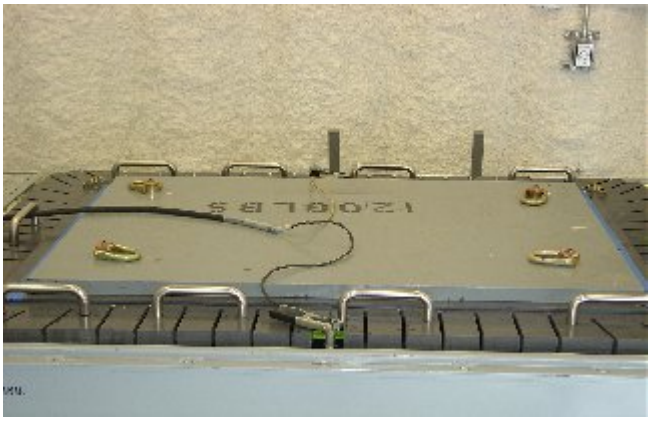

Fig. 4. Macro liner being sealed.

The UltraTech macro-liners systems to be employed by NTS meet the intent of the EPA's "MACRO" definition to "substantially reduce surface exposure to potential leaching media" without having to credit the additional protection provided by the filler material.

EPA technical document *Advances in Encapsulation Technologies for the Management of Mercury-Contaminated Hazardous Wastes* (Section 2.3) discusses the technology selected for use by NSO to perform treatment of MLLW debris at the NTS. The use of polyethylene encapsulation meets the regulatory requirements of alternative treatment standards for hazardous debris.

In a letter from Tim Murphy, NDEP, to E. Frank Di Sanza, NSO, dated November 1, 2007, NDEP approved the use of this macroencapsulation process as an alternative treatment standard for radioactive leads solids.

[1] The filler material, such as vermiculite, acts as a protective coating because of its adsorbent properties.

[2] The filler material shown is a two-part, highly flowable polyurethane foam. NTS filler material will be vermiculite.

FINAL DISPOSITION OF TREATED WASTE

The containers of treated waste will remain in storage and be managed in accordance to the MCA on the TRU waste storage pad until the waste profile is approved. Following approval, the treated containers will be transferred to the MWDU at the NTS for final disposal.

CONCLUSION

MLLW debris is generated from various activities on the NTS. In accordance with the NTSWAC, treatment of these waste streams is required to meet Land Disposal Restrictions identified in the 40 CFR 268 prior to disposal in the permitted MWDU at the NTS. Waste streams that conform to the definition of debris will be treated utilizing macroencapsulation as an alternative treatment standard for hazardous debris prior to disposal. Utilizing the UltraTech macro liner systems meets the intent of the alternative treatment standard for hazardous debris macroencapsulation. The treated waste can be certified to meet the Land Disposal Requirements for disposal. This has proven to be a cost-effective method for treating on-site generated MLLW. In addition, the risks associated with transportation to off-site treatment facilities have been eliminated.

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