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Title:	Classification of the Z-Pinch Waste Stream as Low-Level Waste for Disposal
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Classification of the Z-Pinch Waste Stream as Low-Level Waste for Disposal

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Purpose

The purpose of this document is to describe the waste stream from Z-Pinch Residual Waste Project that due to worker safety concerns and operational efficiency is a candidate for blending Transuranic and low level waste together and can be safely packaged as low-level waste consistent with DOE Order 435.1 requirements and NRC guidance 10 CFR 61.42. This waste stream consists of the Pu-ICE post-shot containment systems, including plutonium targets, generated from the Z Machine experiments requested by LANL and conducted by SNL/NM. In the past, this TRU waste was shipped back to LANL after Sandia sends the TRU data package to LANL to certify the characterization (by CCP), transport and disposition at WIPP (CBFO) per LANL MOU-0066. The Low Level Waste is managed, characterized, shipped and disposed of at NNSS by SNL/NM per Sandia MOU # 11-S-560.

Description of Waste Stream and Process/Experiment

This waste stream consists of the Pu-ICE post-shot containment systems, including plutonium targets, generated from the Z Machine experiments requested by LANL and conducted by SNL/NM. SNL/NM fabricates the containment systems while LANL fabricates the plutonium targets and ships these targets to SNL/NM. SNL/NM conducts the experiments on the Z Machine and then temporarily stores the waste. The TRU waste is shipped back to LANL for certified characterization and final disposition. The containment system is manufactured of machined components made up primarily of ferrous metals (97.2% by weight) and non-ferrous metals (2.4% by weight), with minor amounts of aluminum, plastic, inorganic, and organic materials. Each waste item in this waste stream contains one post-shot containment system. Although 99.6 % of the materials in the containment system are ferrous and non-ferrous metals, there are minor amounts of other materials such as plastic, epoxy, rubber, glass, vacuum grease, carbon, and piezoelectric actuators. The containment system is manufactured of machined components made up primarily of ferrous metals and non-ferrous metals as listed in Figure 1.0.

Waste Material Parameter	**Weight (pounds)**	**Percent of total weight**
Iron-based metals/alloys	837.4	97.2%
Aluminum-based metals/alloys	0.0	0.0%
Other metals	20.7	2.4%
Other inorganic materials	0.006	0.00%
Cellulosics	0.0	0.0%
Rubber	0.94	0.10%
Plastics (waste materials)	0.72	0.08%
Organic matrix	1.17	0.14%
Inorganic matrix	0.2	0.02%
Soils/Gravels	0.0	0.0%
Steel (packaging materials)	62.0	NA

Waste Material Parameter	Weight (pounds)	Percent of total weight
Plastics (packaging materials)	0.0	NA

Figure 1.0 Z-Pinch Waste Physical Inventory

In a typical SNM experiment, two to four small sized SNM samples (roughly the size of a dime) are mounted within the experimental load (a rectangular "box" with a volume of a few cubic inches). A current pulse of ~10-15 MA flows through the experimental load over a timescale of a few microseconds. This amount of current and energy is sufficient to completely vaporize the experimental load, including the SNM samples. The vaporized material is propelled outward by the Lorentz force generated within the anode-cathode gap region of the load, and reaches velocities of several kilometers per second. This material impinges on the inner baffle of the Upper Containment Chamber where it plates out as vapor deposits onto the cold inner surfaces of the baffle. The typical gross weight of the entire containment vessel that the SNM is now affixed to exceeds 825 lbs. In short, post shot the SNM material is vaporized and plated out over many square centimeters, and is not readily separated from the baffle material within the containment chamber. (referenced from SNL memo Marcus Knudson)

In addition, the Pu in the experiment is vaporized in an inert atmosphere. Experience with molten Pu and it alloys with iron at a relatively low temperature has shown that the Iron/Pu phase diagram shows a eutectic at 410° C. Plutonium metal heated above 410°C in steel will melt through the steel by forming the eutectic. Even when present in small amounts in plutonium, the alloying elements can segregate to grain boundaries, enriching the local alloying concentration and causing local melting or embrittlement at temperatures close to the eutectic temperature. Therefore the vaporized Pu is alloyed with the 825 pounds of iron and chemically bonding with the bulk iron. The Pu cannot be wiped out or even etched out with a rinse and has become an integral part of apparatus. (referenced from SNL memo Marcus Knudson)

Discussion

Los Alamos National Laboratory (LANL) and Sandia National Laboratories (SNL) have established a long-term collaborative experimental program using the Z Machine to study the dynamic properties of transuranic materials, including plutonium. The roles and responsibilities each Laboratory has in the preparation, shipping, execution, analysis, and post-shot disposal of these experiments is defined in a Memorandum of Understanding (MOU) established between SNL and LANL (Sandia MOU # 11-S-560 / LANL MOU-0066).

The LANL responsibilities include the preparation and characterization of all Z Machine plutonium samples. This, in part, consists of documenting detailed radioisotope information for each experimental sample (isotopic content and mass, total mass, dimensions, etc.). The SNL responsibilities include maintaining the safety authorization basis and conducting the experiments at the Z Machine. This requires the use of a containment system that encapsulates the post-experiment plutonium debris. By adhering to these constraints and enforcing them through custodial awareness, SNL and LANL have established processes to safely and securely assemble, ship, test, and ultimately dispose of the transuranic materials.

A small number (~6-8) of expended experimental containment systems, each with different activity levels, are typically accumulated and stored at SNL before final disposal as waste. This is done to minimize the

total stored transuranic residue mass at SNL while still maintaining LANL waste shipment and disposal efficiencies for TRU waste. The suspension of operations at the Waste Isolation Pilot Plan (WIPP) and LANL TA-54 Area G has recently interrupted the processes previously established to remove and dispose of the accumulated Z Machine transuranic waste containment systems. Therefore, to assist in classifying this waste in accordance with 10 CFR Parts 65 and managing the waste radioisotope concentrations, the WM-SVS Radiological Characterizations SMEs evaluated the Nuclear Regulatory Commission's guidance on blending LLW materials.

The materials described above have been determined to be waste. In order to determine the radiological status and disposition path for the Z-Pinch Residual Waste Project, the WM-SVS Radiological Characterization SMEs reviewed the attached radiological data packages to determine if the waste type is eligible to be blended with like wastes in accordance with Nuclear Regulatory Commission (NRC) guidance for Blending of Low-Level Radioactive Waste (LLW) for waste classification.

The WM-SVS Radiological Characterizations SMEs have assessed the radiological data provided by Z-Pinch Project personnel (Attachment I) and have determined that by blending and packaging the waste materials from Shots #14, #15, #17, #18, and #19 that the overall TRU concentrations of the final package will be 90.4 nCi/gr (Attachment II) and eligible for disposal at a low level radioactive waste disposal site.

Through utilization of this blending process, worker protection by reduced contact and single packaging efficiency to one TSDF can be achieved in a cost-effective manner without having to reopen and inspect the Z-Pinch waste, certify this waste for WIPP disposal, and repackage the waste into a WIPP certified container thus reducing not only worker exposure but increasing the operational efficiency of waste management in accordance with DOE O 435.1.

If the containment vessels were to be characterized as a separate waste and packaged individually, due to the transuranic content, they would be above I00 nCi/g TRU and thus considered TRU waste for disposal.

DOE Order 435.1 Guidance, Section III.A indicates that worker safety should be a matter of high importance and that technological rationale should be applied when deciding how to process a waste stream. In Section III-3 the Guidance states, "It is also recognized that actions taken to process a waste stream for safety or technological reasons that are justified, may result in the waste being reclassified after processing as low- level waste."

DOE Order 435.1 Guidance Section III-A also requires that classification of waste be determined at "the time of waste certification that is each time the waste is transferred to another person or facility." The waste stream as packaged must be certified after it is prepared to be transferred to the LLW disposal facilities.

Blending higher activity and lower activity waste can lower the concentration of radioactivity. The mixture would then be suitable for disposal at more locations and at lower cost. NRC regulations do not prohibit blending to lower the waste classification. On October 13, 2010, the Commission issued its Staff Requirements Memorandum for SECY-10-0043. In it, the Commission approved the option to develop a risk-informed, performance-based position on blending, and provided specific guidance on certain issues, such as compatibility, public outreach, and blending of Greater Than Class C waste (GTCC). The revised guidance, published in February 2015, addresses concentration averaging for a variety of wastes, including

blended waste. In March 2015, the staff published a proposed rule to address disposal of blended waste and other waste streams. Existing NRC staff guidance discourages blending in some circumstance, but also recognizes that some blending, including blending that lowers the classification of a waste, may be appropriate in others.

Based on the radiological concentration of the Z Pinch waste stream, it has been determined that the waste type is suitable to blending per the NRC guidelines. Specifically, by blending and packaging the waste materials from Shots #14, #15, #17, #18, and #19 the overall TRU concentrations of the final package will be 90.4 nCi/gr and eligible for disposal at the Nevada National Security Site (NNSS) or WCS (Waste Control Specialists, LLC).

Conclusion

In summary, based on the above guidance, LANL WM has determined the Z Pinch waste stream can be processed and prepared for LLW disposal using existing facilities and equipment to prepare the waste safely (maintain worker exposure as low as reasonably achievable), increase operational efficiently by allowing newly generated waste to be packaged and shipped for disposal in a timely fashion. As a result of this packaging and item concertation calculation effort the waste stream is expected to be classified as low-level waste. The five shots prepared and packaged together results in a waste package that is less than 100 nCi/gm transuranic, thus it is classified as LLW.