Newly-Generated, Remote-Handled TRU Characterization and Certification at Sandia National Laboratories/New Mexico – 14199 (SAND2013-9707C)

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ABSTRACT

The mission of Sandia National Laboratories/New Mexico (Sandia) has historically been to develop technological solutions to support national security in the areas of nuclear weapons, nonproliferation and assessments, military technologies and applications, energy and infrastructure assurance, and homeland security.

In the 1970s and 1980s, Sandia conducted several experiments simulating severe accident scenarios in response to the Three Mile Island incident. In the 1990s, the glove boxes and hot cells used for assembly/disassembly of the experiments were decontaminated and the debris waste generated during decontamination was identified as transuranic (TRU), both contact-handled (CH) and remote-handled (RH). This waste was repackaged under a Waste Isolation Pilot Plant (WIPP) certified program and shipped to WIPP from 2010 through 2012. As part of a de-inventory effort, Sandia has been tasked with identifying a disposal path for the test vessels, intact pins, and pin pieces from these experiments. Discussions between Idaho National Laboratory (INL), WIPP, and Sandia resulted in the determination that the intact pins could be shipped to INL, and the test vessels and pin pieces qualified as TRU material.

With the support and concurrence of the Carlsbad Field Office (CBFO), Sandia contracted with Nuclear Waste Partnerships, LLC (NWP) to provide Central Characterization Project (CCP) certified acceptable knowledge (AK), radiological, and visual examination (VE) support for the repackaging effort. The challenges are many due to the configuration of the Auxiliary Hot Cell Facility (AHCF), the size and configuration of the current containers, and the high dose rates.

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INTRODUCTION

Sandia conducted several projects as part of the Severe Accident Research Program resulting from the Three Mile Island accident. Experiments were performed over several years investigating severe accident scenarios from fuel disruption, axial relocation of breeder reactor fuel, and vapor pressure of mixed oxide (MOX) fuels during reactor accidents. The majority of the materials used for these experiments were MOX pins fabricated by the Hanford Engineering Development Laboratory (HEDL) and irradiated in the Experimental Breeder Reactor (EBR)-II. There are lesser quantities of materials fabricated at other U.S. laboratories and irradiated in various reactors. The Hot Cell Facility (HCF) at Sandia, where these experiments were assembled, was decontaminated in the 1990s and the TRU debris waste generated from decontamination was characterized, certified, and shipped to WIPP between 2010 and 2012. That waste stream, SNL-HCF-S5400-RH, is described in the *CCP Acceptable Knowledge Summary Report*, CCP-AK-SNL-500 (1). The test vessels, intact pins, and remaining pin pieces continued to be managed as material since there was interest for continued investigations of these materials or it was thought they would be shipped to INL as spent nuclear fuel.

In 2012, Sandia began evaluating the material in storage to determine if there was continued interest in storing the material for possible future projects, or if disposal was an option. A list of items was prepared and sent to INL. However, based on the physical form of the post irradiation examination materials, questions were raised whether these materials should be disposed of at WIPP. Sandia contracted with AK experts who evaluated the material list and prepared a letter report, *TRU Waste Currently Stored at SNL,* SJS-121001(2), identifying items that potentially could be TRU waste and those that could be sent to INL as spent fuel. Two paths were identified; one to INL and one to WIPP, and Sandia began the nuclear materials disposal process. The material is tracked by Sandia's MC&A group and any material determined to be disposed of at WIPP will require Termination of Safeguards.

DISCUSSION

The materials are packaged in various cask configurations which are not compliant with WIPP or the Department of Transportation (DOT) and are being repackaged as RH in the AHCF located in Technical Area (TA) V. There are significant differences in the material, the physical configuration, and the dose rates which are challenging to the hot cell operators and the VE experts. The inventory is divided into four categories discussed below with each category worked as a separate campaign.

Intact Pins/Campaign 13

The first category consists of intact pins packaged in four (4) fuel pin casks, containing 27 intact fuel pins. Sandia requested the pins but never used them in experiments because the program was terminated early. Sandia believes that some testing may have occurred prior to delivery to Sandia, but Sandia did not perform any destructive testing on these pins. Sandia did conduct gamma spectroscopy on these materials. Sixteen of the pins are Pacific Northwest Laboratory (PNL) MOX irradiated fuel and 11 are Belgium Reactor-3 (BR-3) irradiated pins fabricated from U.S. uranium oxide (UO_2) fuel. During repackaging, the fuel pins were:

- Sorted into intact versus failed fuel pins,
- If, needed, bent into lengths that could be accommodated in the appropriate NAC screened can or sealed can, and
- Repackaged in a Nuclear Assurance Corporation (NAC) screened can or sealed can and will be shipped to INL in the NAC-Legal Weight Truck (LWT) casks at a later date.

The original casks were decontaminated for re-application or disposal.

Table I lists the physical and radiological data (3) of each cask and Figure 1 is an example of the storage casks (4).

TABLE I. Container Information

Container Number	Dimensions (meters)	Gross Weight (kilograms)	Calculated unshielded dose rate (mSv/hr)
C00217661	2.2 m x 0.5 m	5,216	1.6E+04
C00217662	2.1m x 0.48 m	2,268	1.3E+04
C00217663	1.9 m x 0.6 m	4,763	2.3E+04
C00217698	2.2 m x 0.6 m	5,262	2.9E+04

Figure 1. Fuel Pin Cask

Experimental Packages in Shielded Casks/Campaign 11

Eighteen experimental assemblies with MOX are contained in shielded Fuel Disruption (FD) casks which are over-packed into 0.208 cubic meter (m^3) drums with the nineteenth assembly in a 0.114 m^3 drum. The assemblies weigh approximately 27 kg each with cask gross weights ranging from 89 kg to 769 kg (4). Figure 2 is an example of an experimental assembly configuration.

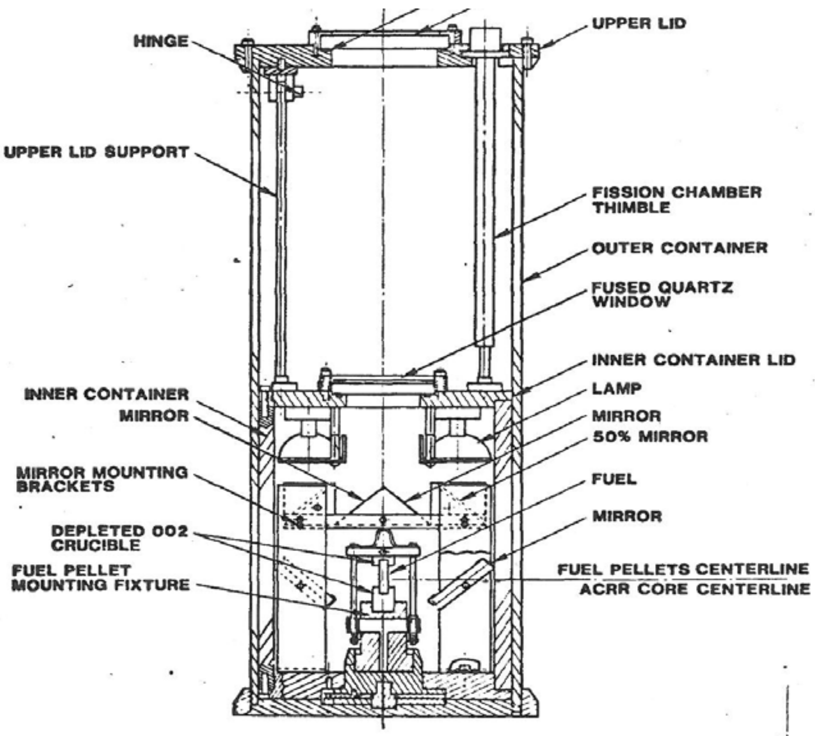

Figure 2. Experimental Assembly

The MOX material is associated with the FD experiments. In most of the experiments, the MOX material did not experience any extensive damage and it is anticipated that there is limited contamination, and the material can be removed and disposed of as TRU waste with the remaining assembly qualifying as low-level (LL) waste. However, in a few experiments, melting, frothing, spraying, and splattering likely spread material to the inner walls of the experimental assembly(4). The calculated unshielded dose rates range from 1.8E+02 to 8.7E+02 mSv/hr (3).

Excess Pins and Pieces/Campaign 12

There are eleven (11) containers with MOX and UO_2 pieces, pellets, kerf, and experimental hardware. The pin pieces are in bags or metal tubes, marked with the fuel type, placed in drums, and over-packed into casks. Other items were placed into cans or directly loaded into shielded containers. Material from the Source Term (ST) experiments was fission-heated and partially molten, then potted in epoxy and cut, producing the kerf material. Figures 3 and 4 are examples of storage configurations. Container weights vary from 42 kg to approximately 2,000 kg (4), with calculated unshielded dose rates of 1.1E+02 to 2.6E+04 mSv/hr (3).

Figure 3. Casks for Pins, Pieces, and Experimental Hardware

Figure 4. Shielded Cask

Dense Pack/Campaign 14

The Sandia Transient Axial Relocation (STAR), FD, and Effective Equation of State (EEOS) experimental assemblies were unable to be stored in shielded casks due to their size and are stored in the engineered Dense Pack storage facility at TA-V. There are seven assemblies ranging in length from 76 cm to 3.1 m, are 23 cm in diameter, and weigh around113 kg. The material for the STAR experiments was placed in a quartz tube and is thought to be contained within that tube after completion of the experiment. The FD assemblies are similar to those in Campaign 11 and may be contained in a material bundle (4). The EEOS experiment involved intense heat and the material likely melted during irradiation, so the assembly may be contaminated with material throughout. Most of these items require significant size reduction and have calculated unshielded dose rates ranging from 2.1E+00 to 3.7E+04mSv/hr (3). Figure 5 is an example of one of these (4).

Figure 5. Experimental Assembly Stored in Dense Pack

The challenges are many due to the configuration of the AHCF and the containers including:

- Entry into the AHCF is through the roof of the hot cell,
- Weight of the containers ranges from a few hundred pounds to several thousand pounds,
- Unshielded dose rates are high, and
- Physical dimensions of some of the test vessels are greater than three (3) meters long and 23 cm in diameter.

The opening in the roof of the hot cell is not large enough to allow many of the casks to be lowered into the hot cell. Therefore, the casks are opened behind the shield wall and then the inner container is lifted and transferred into the hot cell. In some cases, such as the intact pins, the contents are removed from the inner container before moving the material into the hot cell. The hot cell is shown in Figure 6.

Figure 6. Auxiliary Hot Cell

WIPP Characterization and Certification

Once a path forward determination was made for the materials, Sandia began working with INL for the packaging and shipment requirements for the intact pins, and contracted with NWP to provide characterization and certification for those materials that potentially qualified for WIPP disposal. This discussion will focus on the WIPP material only.

A contract between Sandia and NWP was initiated based on a cost estimate provided by NWP to Sandia. Once the contract was negotiated and signed, an AK Summary Report was prepared and approved. Many of the source documents were the same as those in the AK summary report for the debris waste (1). The radiological pedigrees are well documented for all of the materials used in the experiments as the radiological information had been tracked and confirmed from procurement, receipt, during experimentation and packaging in Sandia's accountable-material database. This allowed the radiological engineer to use ORIGEN© to determine the radiological scaling factors for the radiological report.

Sandia, NWP, and CBFO have a conference call every two weeks to discuss progress, schedule impacts, information needs, and resolve issues. The WIPP repackaging effort began in February and is expected to take 44-48 weeks, so the decision was made for NWP to identify two VE operators who would relocate to Albuquerque for the duration to reduce the cost of per diem. Sandia provided the VE operators additional on-site training in January.

Transferring items in and out of the hot cell is challenging because entry is through the roof and the opening is only 91 cm in diameter. Most of the material has been packaged in smaller containers and then placed into casks. The large casks cannot fit through the roof opening and the AHCF overhead crane is not certified to handle the weight of the large casks. In an effort to minimize the amount of waste, FD experiments, large casks, and some packages will be opened behind the shield wall, when possible, and broken down to a minimum inner container. There are in-floor silos behind the shield wall for storing items until they are ready for transfer into the hot cell, thus reducing the dose issues for personnel. The large experimental packages from the Dense Pack are too long to fit inside the hot cell, so they will be size reduced outside the hot cell behind the shield wall. This will be the last packaging campaign.

The packaging of the waste into WIPP compliant containers follows the same protocol as the previous packaging of the debris waste except if the size of items allows the use of shield pots. The pin pieces, pellets, and small items from the experimental packages are candidates for the shield pots. Other items will require size reduction, but ultimately, waste is loaded into shield pots or direct loaded into 0.114 m^3 drums, removed from the hot cell and placed in 0.208 m^3 drums. Both drums are filtered with WIPP compliant filters. The drums are then staged awaiting dose-to-curie measurements.

After the shipment of the debris waste in 2012, WIPP closed out the baseline certification program at Sandia. Therefore, a new baseline report requires the U.S. Environmental Protection Agency's (EPA) approval. In addition to EPA, New Mexico Environment Department and Carlsbad Technical Assistance Contractor personnel will schedule a visit to Sandia to observe the operations. A baseline report will be submitted to EPA with a 45-day public comment period. Once the baseline report is approved and repackaging and characterization is complete, the containers can be certified and Sandia will be ready to begin shipments. Sandia has requested incremental shipping, but CBFO has indicated they would prefer shipping all containers at once. If a window of opportunity arises due to inclement weather or other issues at other sites, CBFO will evaluate Sandia's request.

CONCLUSIONS

Beginning in November of 2012, Sandia, Sandia Field Office, CBFO, INL, and NWP have worked to develop and implement a path forward for the fuel transfer to INL and disposal of TRU material to WIPP. The material is similar to other material that has been sent to WIPP from Argonne National Laboratory and that has been very helpful to Sandia and significantly reduced the time to plan and begin implementation. The biggest challenges have been long lead times for contract implementation, information gathering, procurement of materials, and the logistical issues. New tools had to be designed and manufactured, archived documents had to be retrieved, several groups were involved, and many conference calls held. However, it was apparent that the end goals were the same for all involved and project start-up occurred as scheduled.

Updates will be documented in a future presentation.

REFERENCES

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