LA-UR- 10-03828

Approved for public release; distribution is unlimited.

Title: Disposition of Fuel Elements from the Aberdeen and Sandia Pulse Reactor (SPR-II) Assemblies

Author(s): Jacqueline M. Bustamante, David A. Costa, Anthony F. Drypolcher, Joseph Hickey, and Bill McKerley

Intended for: 51th Annual Meeting of the Institute of Nuclear Materials Management
July 11-15, 2010
Marriott Baltimore Waterfront Hotel
Baltimore, Maryland

Los Alamos
NATIONAL LABORATORY
EST. 1943

DISPOSITION OF FUEL ELEMENTS FROM THE ABERDEEN AND SANDIA PULSE REACTOR (SPR-II) ASSEMBLIES

Jacqueline M. Bustamante, David A. Costa, Anthony F. Drypolcher, Joseph Hickey, and Bill McKerley
Los Alamos National Laboratory
P.O. Box 1663, MS E-511, Los Alamos, NM 87544

ABSTRACT
We describe the disposition of fuel from the Aberdeen (APR) and the Sandia Pulse Reactors (SPR-II) which were used to provide intense neutron bursts for radiation effects testing. The enriched Uranium - 10% Molybdenum fuel from these reactors was shipped to the Los Alamos National Laboratory (LANL) for size reduction prior to shipment to the Savannah River Site (SRS) for final disposition in the H Canyon facility. The Shipper/Receiver Agreements (SRA), intra-DOE interfaces, criticality safety evaluations, safety and quality requirements and key materials management issues required for the successful completion of this project will be presented. This work is in support of the DOE Consolidation and Disposition program.

INTRODUCTION
Sandia National Laboratories (SNL) has operated pulse nuclear reactor research facilities for the Department of Energy since 1961. The Sandia Pulse Reactor (SPR-II) was a bare metal Godiva-type reactor. The reactor facilities have been used for research and development of nuclear and non-nuclear weapon systems, advanced nuclear reactors, reactor safety, simulation sources and energy related programs. The SPR-II was a fast burst reactor, designed and constructed by SNL that became operational in 1967. The SPR-II core was a solid-metal fuel enriched to 93% ^{235}U. The uranium was alloyed with 10 weight percent molybdenum to ensure the phase stabilization of the fuel. The core consisted of six fuel plates divided into two assemblies of three plates each [1].

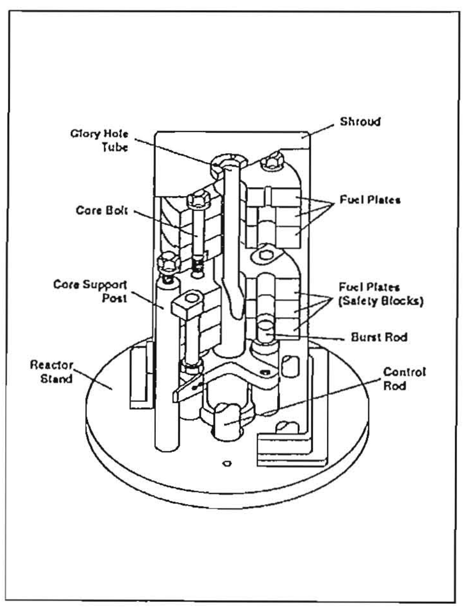

Figure 1. Cutaway diagram of the SPR-II Reactor.

Figure 1 shows a cutaway diagram of the SPR-II Reactor with its decoupling shroud.

NNSA charged Sandia with removing its category 1 and 2 special nuclear material by the end of 2008. The main impetus for this activity was based on NNSA Administrator Tom D'Agostino's six focus areas to reenergize NNSA's nuclear material consolidation and disposition efforts. For example, the removal of SPR-II from SNL to DAF was part of this undertaking. This project was in support of NNSA's efforts to consolidate the locations of special nuclear material (SNM) to reduce the cost of securing many SNM facilities. The removal of SPR-II from SNL was a significant accomplishment in SNL's de-inventory efforts and played a key role in reducing the number of locations requiring the expensive security measures required for category 1 and 2 SNM facilities.

A similar pulse reactor was fabricated at the Y-12 National Security Complex beginning in the late 1960's. This Aberdeen Pulse Reactor (APR) was operated at the Army Pulse Radiation Facility (APRF) located at the Aberdeen Test Center (ATC) in Maryland. When the APRF was shut down in 2003, a portion of the DOE-owned Special Nuclear Material (SNM) was shipped to an interim facility for storage. Subsequently, the DOE determined that the material from both the SPR-II and the APR would be processed in the H-Canyon at the Savannah River Site (SRS). Because of the SRS receipt requirements some of the material was sent to the Los Alamos National Laboratory (LANL) for size-reduction prior to shipment to the SRS for final disposition.

MATERIAL DESCRIPTION AND CHARACTERIZATION

The material from the APR and SPR-II destined for size reduction at Los Alamos consisted of: SPR-II – 9 items and APR - 8 items (7 plates and one annulus). Table 1 presents information pertaining to the SPR-II and APR items.

Table 1. Details of the items (16 plates and 1 annulus) from the SPR-II and APR.

Item No.	741 Net Wt. (g)	U Wt. (g)	Diam./Ht. (cm)	Shape
339	3460	3114	22.86/0.79	plate/ring
341	2742	2468	22.86/0.79	plate/ring
103	14682	13214	22.86/3.81	plate/ring
104	14687	13218	22.86/3.81	plate/ring
105	14666	13199	22.86/3.81	plate/ring
106	14639	13175	22.86/3.81	plate/ring
111	14677	13209	22.86/3.81	plate/ring
735	15646	14080	10.16/22.86	annulus
460	16235	14628	20.52/3.54	plate/ring
586	16366	14745	20.52/3.38	plate/ring
461	16447	14766	20.52/3.38	plate/ring
585	16433	14826	20.52/3.38	plate/ring
351	16243	14616	20.52/3.54	plate/ring
456	16259	14664	20.52/3.54	plate/ring
116	17159	15443	20.52/3.54	plate/ring
102	16262	14636	20.52/3.38	plate/ring
427	16311	14608	20.52/3.38	plate/ring

Figure 2 shows the first plate from the APR (smaller and darker) and the first plate from the SPR-II (larger and lighter in color) to be introduced to the glovebox at PF-4 in preparation for size reduction. Figure 3 shows a closer view of the first SPR-II plate introduced into the glovebox line for size reduction.

Figure 2. Plates from the APR (smaller and darker, approx 2.7 kg net. wt.) and the first plate from the SPR-II (larger and lighter in color, approx. 16 kg net wt.).

Figure 3. Plate from the SPR-II (approx. 16 kg net wt.).

ADMINISTRATIVE REQUIREMENTS

It was determined that this highly enriched uranium (HEU) material was to be shipped to its final disposition destination at the Savannah River Site (SRS) and the H Canyon dissolvers. Due to the size of the material, size reduction was required in order for the material to fit into the dissolvers. Consequently, it was decided that the material would be sent to LANL for size reduction prior to shipment to SRS. Detailed agreements between the various sites were required before the project could begin. These Shipper/Receiver Agreements (S/RA) [2] described the material control and accountability (MC&A) requirements associated with the shipment of highly enriched uranium (HEU) material from each interim site to its final disposition destination at the Savannah River Site (SRS). The purpose of these documents was to clarify the requirements of the transfer of this material from the interim storage location at the Nevada Test Site (NTS), to Los Alamos National Laboratory (LANL), and from LANL to SRS. In addition these documents addressed schedule limitations at LANL. The DOE M 470.4-6, Change 1, "Nuclear Material Control and Accountability" requires verification/accountability measurements to be completed within 30 calendar days of receipt of material. This time constraint could not be met at LANL and the verification and/or accountability measurements were completed as documented and approved. It was determined by the sites that this material was to be handled as Category I, Attractiveness Level B. The S/RAs were separated into sections based on each site's requirements for shipping and receiving. The S/RAs did not include step-by-step instructions for physical handling of the material. These step-by-step instructions were contained in site-specific procedures at each of the sites.

Site specific criteria included measurement and measurement related activities, specific packaging and handling requirements for the DT-23 and ES-3100 shipping containers, shipping forms and transfer documents such as DOE/NRC Form 741(s), and authorization to ship documentation. Once the shipping containers were offloaded from the transport vehicle, a transfer/verification check was made against shipping documentation within 5 working days, confirming shipping container count and identity, validation of TID integrity and identification, and shipping container gross weight. The requirements for material confirmation and verification measurements were described. In addition, the S/RAs presented details pertaining to evaluation--accept/reject criteria including transfer/confirmation checks, verification/accountability measurements, and resolution of shipper/receiver differences.

These S/RAs defined the interactions between the various sites and formed the foundation for the activities required to complete the project in advance of any material movement.

The proposed size reduction activities of the HEU items in the gloveboxes at PF-4 were characterized as a new operation and required a number of facility reviews and approvals prior to the start of work. A Joint Evaluation Team (JET) met in early July 2009 to discuss the appropriate level of readiness review required to implement the addition of new equipment into the glovebox in PF-4 for the size reduction of these plates. The JET recommended to the NNSA Los Alamos Site Office (LASO) that a contractor approved Readiness Assessment was the appropriate level of review to implement this addition. The recommendation was based on the JET's determination that the addition of this new equipment represented a positive answer to two of the Secondary Screening Factors: 1.

the installation/operation of new equipment, and 2. the development or substantial modification of operational procedures.

Based upon this decision, it was decided that in compliance with DOE Order 425.1C, its standard DOE-STD-3006-00, and LANL P115 that a Laboratory (Contractor) Readiness Assessment (LRA) be conducted. A limited scope Management Self Assessment (MSA) and LRA were to be performed to verify/validate readiness of operations. The resulting Plan of Action (POA) [3] specified the core requirements (scope and breadth of the readiness assessment), assigned the team leader responsible for conducting the LRA, the projected dates for performance of the review and prerequisites necessary for initiation of the LRA. This POA also utilized an LRA Checklist that provided the depth of the assessment and served as the final report. The MSA was completed and the LRA was initiated in late October 2009. All findings and recommendations were resolved and approval for full scale operations was received in mid December 2009.

Primavera scheduling software was used to develop a fully loaded cost, scope and schedule. This document evolved into a 19 page, detailed schedule for project tracking and statusing. In addition, bi-weekly video teleconferences (VTC) were held with all participating sites. During these VTCs, all components of the schedule were reviewed to ensure that activities were on schedule and to provide an opportunity to resolve any inter-site issues or questions that might arise. Although this was somewhat time intensive, the end result justified the time investment. One of the key motivations for this focus on schedule was the SRS H Canyon processing campaign. The SRS was under direction from the DOE to complete their "non-irradiated" material campaign by the end of FY10. The H Canyon facility would transition to the "irradiated material" campaign at the first of FY11. Consequently, all of the size reduced material was required to be at SRS by the end of June 2010 to ensure the completion of processing of this material prior to the transition of the dissolvers to the "irradiated material" campaign

TECHNICAL AND OPERATIONAL ACTIVITIES

Several approaches to the handling of this material such as oxidation or size reduction at another site at LANL using a large shear were considered and rejected. Due to a number of constraints, the decision was made to size reduce the material using a saw.

Figure 4 shows the first APR plate size reduced into 4 pieces

The first small plate was cut into four pieces using a manual saw. In the foreground of Figure 2, the manual saw can be seen it its stand. Figure 4 shows the first APR plate size reduced into 4 pieces in compliance with the size restriction of the SRS H Canyon dissolver. SRS also requested a small sample in order to perform dissolution/solubility studies prior to introducing the material into their dissolvers. A small, 50 g sample was cut from one of the pieces, prepared and sent to SRS for analysis. Once the results from these studies confirmed that the material was compatible with their dissolvers, LANL was given approval to ship the material.

A review was conducted after completion of the first size reduction activity. The initial cutting operation utilized a hack saw to cut the plates. To improve the ergonomic and ALARA aspects of the process a Milwaukee's Deep Cut Portable Band Saw having a cutting capacity of 4-3/4 in. x 4-3/4 in. was evaluated in a "cold laboratory" setting on surrogate material and was determined to be acceptable. The band saw employed high torque and a powerful motor to maintain a steady, optimum blade speed. The excellent balance, high visibility and quick blade change system made this band saw relatively easy to work with in a glovebox. A self-lubricating system was used for maximum wear resistance and long life. Consequently, no oiling was needed. This elimination of cutting oil was a very important consideration for the H Canyon dissolver system. The band saw was mounted as a stationary unit on a Milwaukee portable band saw table accessory. The HEU plates were mounted on a table using clamps or a vice and were sectioned.

Figure 5. Milwaukee's Deep Cut Portable Band Saw

Figure 5 shows the band saw configuration with a mock-up of a large plate, typical of the set up employed in the glovebox.

The band saw provided a significant level of efficiency in cutting the plates. However, due to the hardness of the material, an average of 5 blades was required per cut or approximately 20 blades per plate. The cutting surface of the blades would dull quickly and frequent blade changes were required. Several blades were weighed and no detectable weight loss was noted (< 0.1 g weight loss per blade). Initial estimates suggested that the "saw fines" would be less than 250 g net weight. However, due to the required blade design (3 teeth/2.5 cm.) the amount of saw fines was significantly greater than originally anticipated. Figure 6 shows a size reduced plate and a container of "fines" resulting from the cutting operations. The final values were: Net Weight - 2823 grams, U Weight – 2541, and ^{235}U Weight - 2367 grams. A revision to the shipping plans was required in order to obtain approval to ship this additional and unexpected amount of material to SRS.

Figure 6. Size reduced plate and associated fines.

Most of the HEU-Mo metal was slightly irradiated as indicated by the information in Table 2 and included minor concentrations of mixed fission and activation products. In order to ensure that exposures were maintained As Low As Reasonably Achievable (ALARA), the plates and the annulus were covered with lead plate whenever operations were not in progress.

Table 2. Typical dose readings from the plates.

	Readings (mR/hr)			
Net Wt.	**1"**	**12"**	**40"**	**Form**
3460	350	38	3	plate
2742	435	48	3	plate
14682	1000	120	50	plate
14687	1000	100	50	plate
14666	800	90	50	plate
14639	800	90	45	plate
14677	1400	120	60	plate
15646	800	80	40	annulus

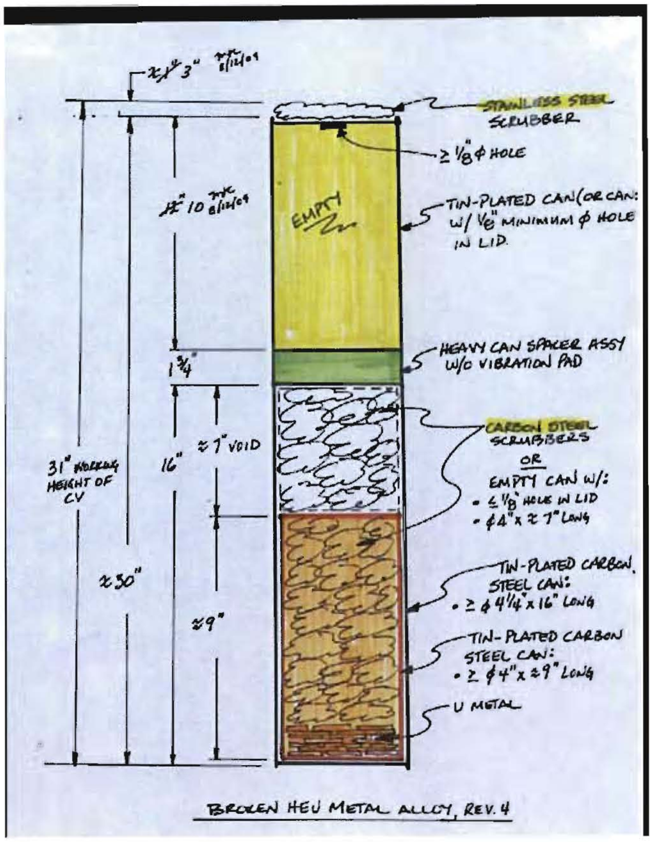

Figure 7. Packaging engineer drawing of typical ES-3100 package configuration.

The HEU-Mo metal parts were cut into pieces weighing less than 5.0 kg each. The size-reduced HEU-Mo metal was then packaged into a 4" x 8.75" Inner Convenience Can (ICC). The 4" x 8.75" ICCs were then placed in a nylon bag-out bag, tied with a nylon tie wrap, and placed into a 4.25" x 16" Outer Convenience Cans (OCC). The crimp sealed OCC was then packaged into a U.S. Department of Transportation (DOT) ES-3100 shipping container according to the shipper-receiver authorization form. The ES-3100s were packaged according to an approved Loading Checklist [4].

Figure 7 shows the packaging configuration of a typical ES-3100 shipping container. The ES-3100 would accommodate only one 4.25" x 16" OCC due to a 31" stack height limitation. Consequently, empty smaller cans and/or fill material was used to ensure that the loaded OCC was secure during transport. The project required the use of 70 ES-3100s in order to transfer all of the size reduced material to SRS.

CONCLUSIONS

At the beginning, one of the authors was encouraged to complete the assignment but "not to make a project out of it". The original scope did not appear to be particularly daunting. Initially, the goal of size reducing 17 HEU items and shipping the resulting pieces to SRS for processing seemed relatively straight forward. It soon became obvious that achieving this goal within the allowed timeframe and within the myriad constraints and requirements would be extremely challenging. The fact that the material was size reduced and shipped to SRS prior to the end of June 2010 was a significant achievement. The fact that this occurred with no accidents, incidents or injuries is most gratifying.

This could not have been accomplished without the close coordination between the sites and many dedicated individuals. The authors wish to thank all those who came together to make this a success. Special appreciation and recognition are extended to the dedicated and capable men and women who work in PF-4. Without their hard work and expertise this and many other important projects would not succeeded.

A special word of appreciation is extended to Xavier Ascanio and Dale Dunsworth, Office of Nuclear Materials Integration (NA-58) for their support.

REFERENCES

1. T.R. Schmidt and J.A. Reuscher, "Overview of Sandia National Laboratories Pulse Nuclear Reactor," SAND94-2466C, Sandia National Laboratories, Albuquerque, NM, 1994
2. *Nuclear Materials Control and Accountability Shipper/Receiver Agreement for Uranium Material For Downblending*, March 13, 2009 and *Nuclear Materials Control and Accountability Shipper/Receiver Agreement for SPR-II Uranium Reactor Material For Downblending,* May 29, 2009
3. *Plan of Action for Management Self Assessment and Laboratory (Contractor) Readiness Assessment for the Size Reduction of Pulse Reactor Metal (HEU/Mo) Plates At TA-55*, August 3, 2009, Los Alamos National Laboratory
4. *Safety Analysis Information for Processing of HEU-Mo Alloy Metal at the LANL TA-55 Plutonium Facility and Shipping to the Savannah River Site, Rev.1*, January 2009, Los Alamos National Laboratory