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REMOVAL OF LEGACY PLUTONIUM MATERIALS FROM SWEDEN

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ABSTRACT

U.S. Department of Energy's National Nuclear Security Administration (NNSA) Office of Global Threat Reduction (GTRI) recently removed legacy plutonium materials from Sweden in collaboration with AB SVAFO, Sweden. This paper details the activities undertaken through the U.S. receiving site (Savannah River Site (SRS)) to support the characterization, stabilization, packaging and removal of legacy plutonium materials from Sweden in 2012. This effort was undertaken as part of GTRI's Gap Materials Program and culminated with the successful removal of plutonium from Sweden as announced at the 2012 Nuclear Security Summit. The removal and shipment of plutonium materials to the United States was the first of its kind under NNSA's Global Threat Reduction Initiative. The Environmental Assessment for the U.S. receipt of gap plutonium material was approved in May 2010. Since then, the multi-year process yielded many first time accomplishments associated with plutonium packaging and transport activities including the application of the of DOE-STD-3013 stabilization requirements to treat plutonium materials outside the U.S., the development of an acceptance criteria for receipt of plutonium from a foreign country, the development and application of a versatile process flow sheet for the packaging of legacy plutonium materials, the identification of a plutonium container configuration, the first international certificate validation of the 9975 shipping package and the first intercontinental shipment using the 9975 shipping package. This paper will detail the technical considerations in developing the packaging process flow sheet, defining the key elements of the flow sheet and its implementation, determining the criteria used in the selection of the transport package, developing the technical basis for the package certificate amendment and the reviews with multiple licensing authorities and most importantly integrating the technical activities with the Swedish partners.

INTRODUCTION AND BACKGROUND

Sweden, a global leader in nuclear non proliferation and one of the first countries to return highly enriched uranium (HEU) spent fuel to the U.S. in cooperation with the U.S. Department of Energy, shut down the R2 reactor in Studsvik in 2005 and placed it in a decommissioning state. A small inventory of plutonium materials was being stored in the R2 reactor building on the Studsvik site under AB SVAFO ownership. The plutonium materials remained as legacy materials from activities during the 1950's to the 1970's. As part of the decommissioning and eventual dismantling activities associated with the R2 reactor building, Sweden approached the U.S. Department of Energy for assistance in finding a disposition path for the very small inventory of legacy plutonium materials.

The U.S Department of Energy's National Nuclear Security Administration's (NNSA) Global Threat Reduction Initiative (GTRI) mission is to reduce and protect vulnerable nuclear and radiological materials at civilian sites around the world. GTRI has worked in over 100 countries around the world to implement nuclear and radiological threat reduction efforts in support of this goal. In response to the request from Sweden, an activity was initiated under GTRI's Gap Materials Program to work with AB SVAFO, Sweden to facilitate safe disposition of the plutonium materials. The mission to remove plutonium from Sweden was initiated in 2009 and completed in 2012. This paper details the technical considerations in developing the packaging process flow sheet, defining the key elements of the flow sheet and its implementation, determining the criteria used in the selection of the transport package, developing the technical basis for the package certificate amendment and the reviews with multiple licensing authorities and most importantly integrating the technical activities with the Swedish partners.

OVERVIEW OF GTRI GAP MATERIALS

There are three separate programs within the GTRI mission goal to remove and dispose of excess nuclear and radiological materials: U.S.-Origin Return Program to return U.S.-origin HEU and LEU (low enriched uranium) to the United States for disposition, Russian-Origin Return Program to return Russian-origin HEU to Russia for Disposition, and the Gap Materials Program. The Gap Materials Program includes materials such as:

- Spent Nuclear Fuel (SNF) containing non-U.S.-origin HEU;
- SNF containing U.S.-origin HEU that was not previously addressed in the Foreign Research Reactor Spent Nuclear Fuel (FRRSNF) acceptance program Environmental Impact Statement (EIS);
- Weapons-usable plutonium that has been separated from SNF;
- U.S. and non-U.S.-origin fresh HEU.

There are a number of criteria that need to be adhered to in order to bring Gap materials to the United States. Environmental and legal reviews per the National Environmental Policy Act (NEPA) are required. The NEPA provides the framework for material conditions prior to shipping to the United States and identifies the requirements to be met for Gap materials to be returned to the United States for disposition.

GTRI has extensive experience in removing Gap, FRR HEU, and spent fuel materials. This experience has been gathered over several decades of removal activities. On the other hand, the regulatory approvals for removing Gap plutonium materials were obtained recently in 2010 and

the collaboration with AB SVAFO, Sweden represented the first Gap plutonium materials removal project under GTRI.

FLOWSHEET PROCESS

The roadmap to Gap materials removal and a brief overview of the Gap materials program are provided in Reference [1]. As part of the mission execution phase for the removal of Gap materials from partner countries, a flowsheet was developed to process the plutonium Gap materials. Considerations for the flowsheet included the packaged condition of the materials and transferring the materials from their storage location to a glovebox for processing. The stored materials at the AB SVAFO facility had not been inspected since the early 1990's so a meticulous and deliberate process was implemented to ensure the materials would be properly characterized and catalogued for packaging. Figure 1 provides a synopsis of that movement and inspection process.

The technical basis for removal of the plutonium Gap materials from Sweden included stabilizing the materials in a furnace to remove organics and moisture and repackaging of the materials to meet transportation and U.S. DOE facility receipt requirements. The demonstration of the moisture content less than 0.5 wt% using a thermo gravimetric analyzer was a key element of the acceptance criteria. Stabilization requirements for the plutonium Gap materials are taken from Reference [2]. Figure 2 shows the flowsheet outlining the steps to treat the materials and test them to ensure they meet the acceptance criteria for receipt.

Following stabilization and TGA, the containers were bagged out of the glovebox. Then they were subject to a non-destructive assay (NDA) measurement to determine isotopic percents and impurities and then packaged within the Type B 9975 shipping package for transfer to the U.S. Figure 3 shows the flowsheet outlining the steps identified for final packaging of the materials.

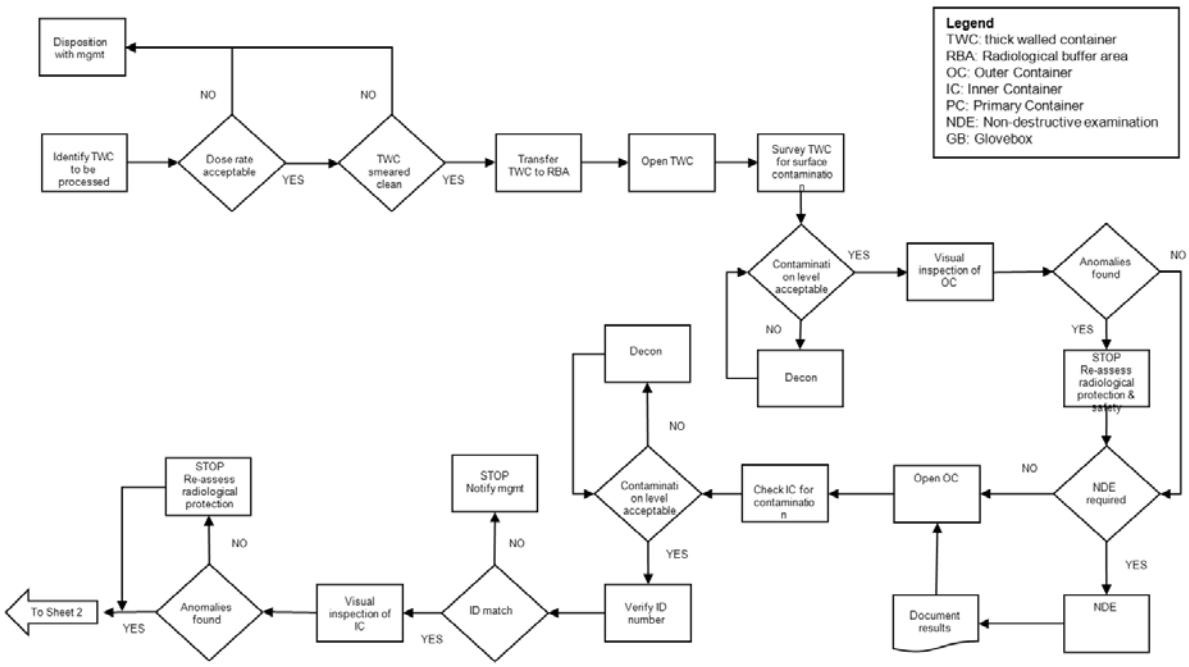

Figure 1. Flowsheet of Operations – Entry into the glovebox

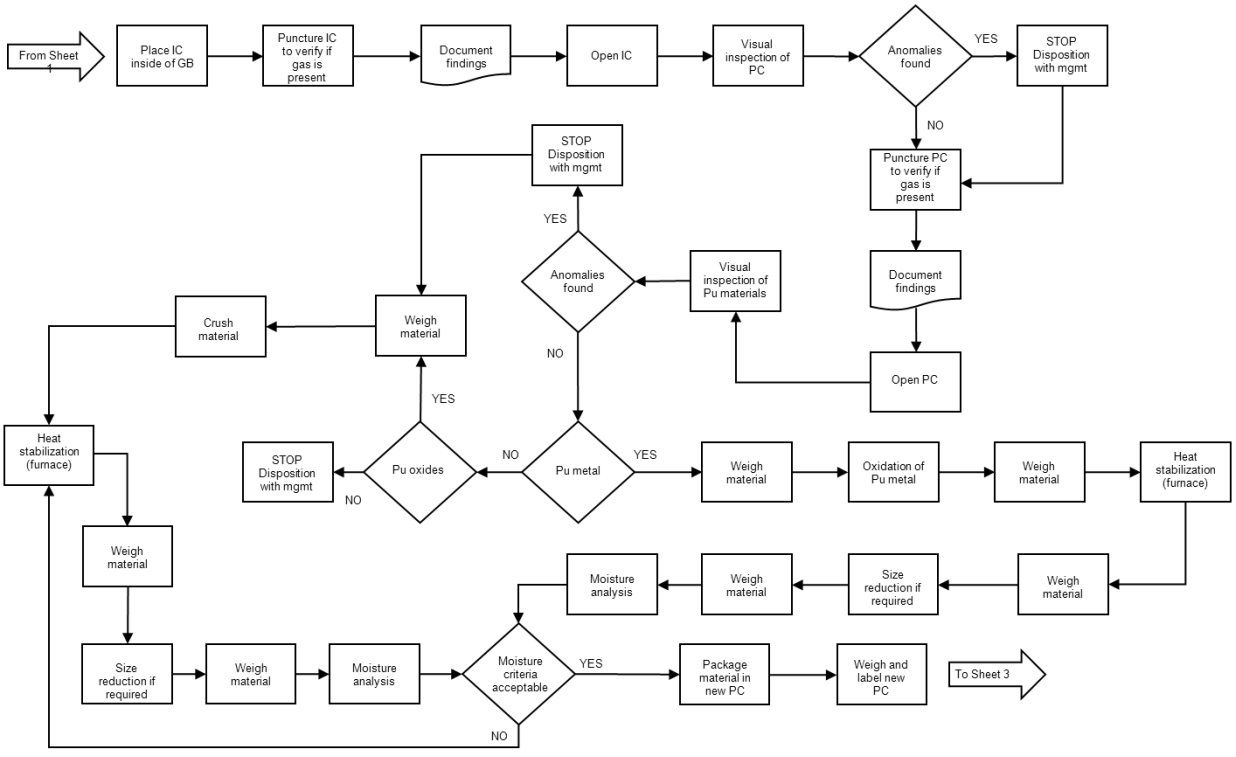

Figure 2. Flowsheet of Operations – Processing Pu materials through glovebox

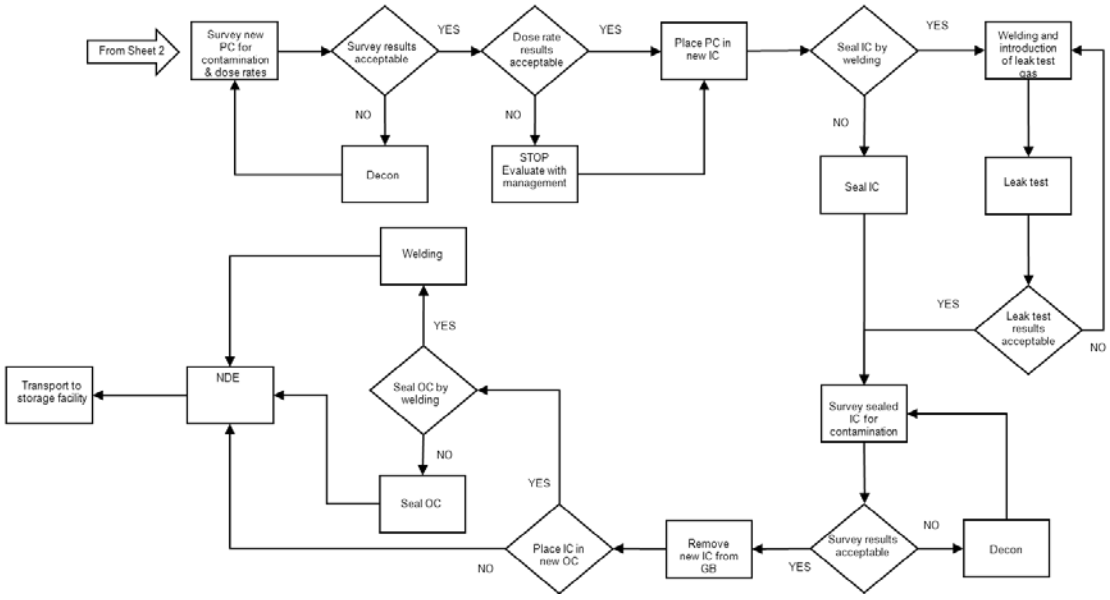

Figure 3. Flowsheet of Operations – Bagging out of glovebox

TECHNICAL BASIS FOR PLUTONIUM CONTAINER CONFIGURATION

A great deal of consideration went into determining the plutonium container configuration for packaging of the AB SVAFO materials. An approved SRS container configuration in the interim storage location at SRS was recognized as the preferred configuration for the AB SVAFO plutonium materials, Figure 4. The SRS configuration consists of a filtered, tape-sealed, stainless steel slip-lid can inside a filtered, heat-sealed bagout sleeve, inside a filtered, stainless steel screw-lid can. This packaged can configuration was then placed directly into a 9975 Shipping Package.

Based on the decades of experience with processing and packaging these types of materials at SRS, this can-bag-can configuration is easy to implement and has proven to be effective for interim storage and also for ease of disposition. It is an approved packaging configuration, within the 9975 Shipping Package and for the interim storage facility at SRS. Of particular interest is that additional safety basis analyses did not need to be implemented for this configuration. A different container configuration may have needed to be re-packaged at SRS, which would have created considerable radiological waste products, unnecessary exposure to the operators, and added cost and effort for the overall operation.

Figure 4. SRS Interim Storage Container Configuration

TECHNICAL BASIS FOR 9975 CERTIFICATE AMENDMENT

As mentioned previously, the 9975 shipping package, Figure 5, is an integrated part of the approved configuration for receipt into the SRS storage location. Therefore, the technical basis for receipt of the plutonium Gap materials also included packaging and transporting in a Type B 9975 shipping package, a package routinely used in the U.S. for transportation of Category 1 plutonium materials. An addendum, Reference [3], for transporting the plutonium Gap materials within the 9975 shipping packages was prepared, approved and a certificate of compliance, Reference [4], was issued. The CoC was then evaluated and validated by the Swedish Regulatory Authority (SSM) for transport from the Studsvik site in Sweden to the U.S. This was the first international certificate validation of the 9975 shipping package and the first intercontinental shipment using the 9975 shipping package

Specific requirements of the Addendum include:

- The primary containment vessel (PCV) shall be inerted with nitrogen so that at the time of closure the oxygen content in all void spaces is no greater than 5 % by volume, Reference [5].
- <100 g plastic
- No restriction on the maximum inter-container radial gap, for foodpack can configurations where all gas spaces in the PCV and foodpack cans are inerted with nitrogen

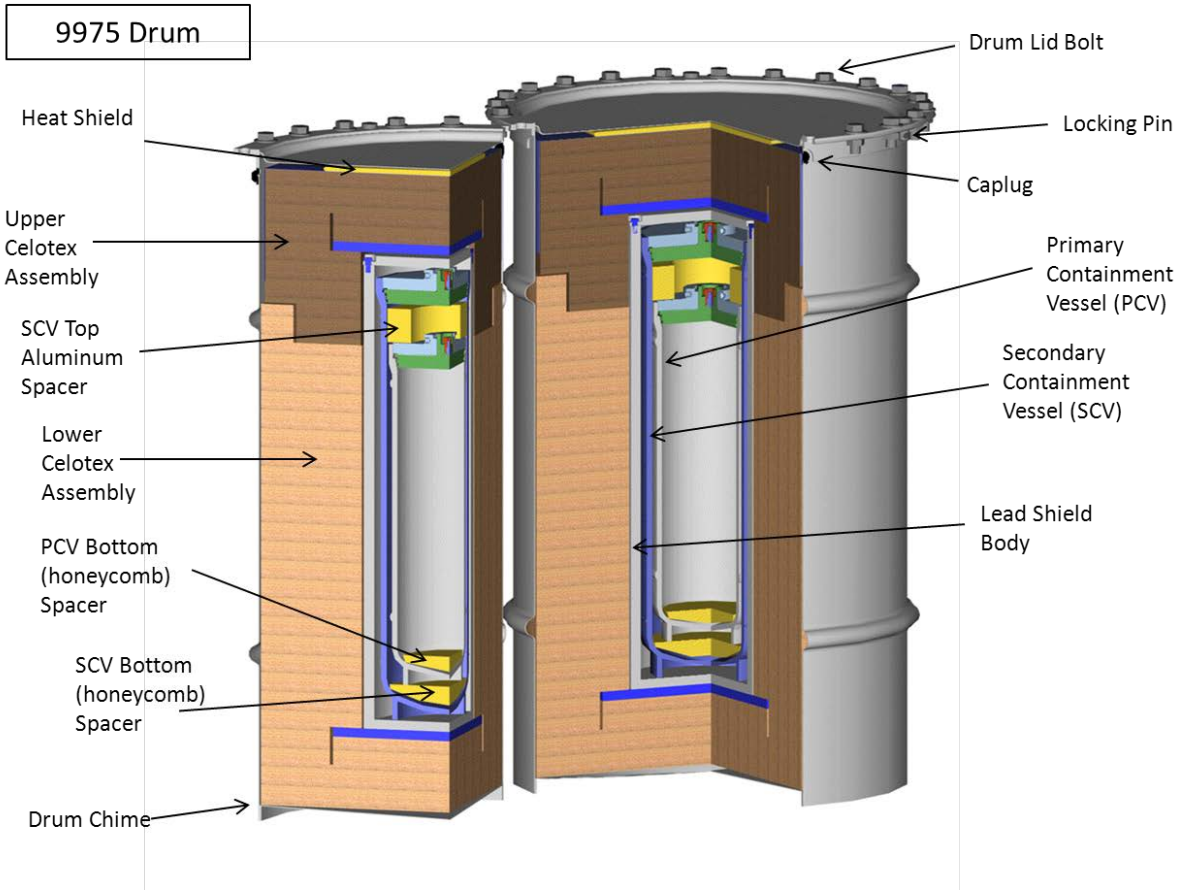

Figure 5. Cutaway of 9975 Shipping Package

GAP MATERIALS PACKAGING OPERATIONS AND TRANSPORT

The plutonium operations were lead by an AB SVAFO team which also included staff from Studsvik and Vattenfall R&D. The GTRI team provided technical support and training throughout this process. Cold testing of the packaging operations and training of personnel commenced in November 2012 (Figure 6) and were conducted in parallel with the final review of the safety documentation by the regulatory authorities. This provided the regulatory authorities the opportunity to observe the cold operations and operator training.

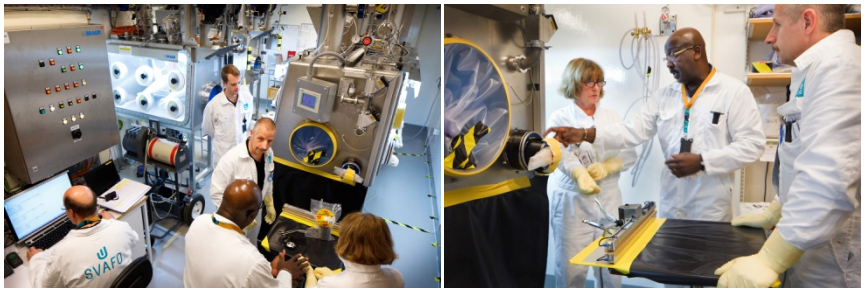

Figure 6: Training of plutonium glove box operators

Radiological operations start-up began mid-January and the packaging campaign was completed by mid-February 2012. Key steps of the packaging operations included removal of containers from the vault, opening of the containers and characterization of the plutonium materials, oxidation of plutonium metal (in some cases) to plutonium oxide, stabilization of the plutonium oxide, measurement of the moisture content using a TGA, packaging the stabilized powder in nested slip-lid/screw lid container configuration, removal of the container from the glove box, packaging in 9975 and leak testing of the final package. The 9975 packages were transported to the U.S. in late February, 2012. Figure 7 and 8 show the glove box activities and final packaged materials.

Figure 7: Stages of plutonium stabilization and packaging operations

Figure 8: 9975 packages ready for transport

SUMMARY AND CONCLUSION

Sweden, a global leader in nonproliferation collaborated with U.S. Department of Energy's National Nuclear Security Administration (NNSA) GTRI to complete the first Gap plutonium removal under the GTRI program as announced at the 2012 Nuclear Security Summit. The removal and shipment of plutonium materials to the United States was the first of its kind under NNSA's Global Threat Reduction Initiative. This effort yielded many first time accomplishments associated with plutonium packaging and transport activities including the application of the of DOE-STD-3013 stabilization requirements to treat plutonium materials outside the U.S., the development of an acceptance criteria for receipt of plutonium from a foreign country, the development and application of a versatile process flow sheet for the packaging of legacy plutonium materials, the identification of a plutonium container configuration, the first international certificate validation of the 9975 shipping package and the first intercontinental shipment using the 9975 shipping package. Sweden's initiative is expected to serve as a catalyst for other Gap plutonium removals.

ACKNOWLEDGEMENTS

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