Management of High-Value Air-Reactive Material at Oak Ridge National Laboratory

Sharon Robinson, Stan Cooper, Jeffery Delashmitt, and Chris Wightman
Oak Ridge National Laboratory
PO Box 2008, Oak Ridge, TN 37831

ABSTRACT

The US Department of Energy (DOE) manages an inventory of materials that contains a range of long-lived radioactive isotopes that were produced from the 1960s through the 1980s by irradiating targets in production reactors to produce special heavy isotopes or isotopically enriching them using the Oak Ridge National Laboratory (ORNL) Calutrons for DOE programmatic use, scientific research, and industrial and medical applications. Since the production reactors and enrichment facilities that produced many of these materials have been shut down, they are considered unique materials that are not likely to be produced again. ORNL uses these materials in DOE's center for production, storage, and distribution of transuranium isotopes (plutonium through californium) and other related nuclear research programs. ORNL also operates the High Flux Isotope Reactor, which provides one of the highest flux neutron sources for production of isotopes for medical, industrial, and nuclear research programs. As a result, ORNL has an inventory of radioisotopes that are being managed for ongoing research programs and being held for reuse because they have potential intrinsic value to DOE. ORNL has an initiative underway to better manage these materials, focusing on high-value and potentially air-reactive materials. This paper describes the actions ORNL is taking to manage these inventories through reuse and disposal.

INTRODUCTION

ORNL recently undertook a multiyear effort to deinventory materials being stored at ORNL and is making a concerted effort to identify unique high-value materials that should be transitioned to users. Although many items in storage had no currently defined use, they were being held at ORNL as potential candidates for reuse because of their intrinsic value to the DOE. Many are important high-purity radioisotopes that are very difficult to produce. In many cases, DOE no longer has the capability to produce these materials [1, 2]. Although they have potential value, the reuse plans for many were not clearly defined. Other items had accumulated in inventory because of a lack of funding, resources, or capabilities for handling radioactive reactive materials. Items might also remain in inventory if they lack sufficient characterization information, a clear disposition pathway, or a potential application. A more robust plan to manage these materials was developed, and activities have been underway for several years to

implement the plan for nonreactive materials. The present efforts are focused on recovery of unique high-value and potentially air-reactive material.

DESCRIPTION

The approach developed for managing these materials is summarized in Figure 1. A more detailed action plan for implementation is shown in Figure 2. Steps are being taken to determine if the materials are potentially air-reactive and whether they have a potential defined programmatic use. The materials are then appropriately processed, packaged, staged, dispositioned, or a combination of these activities.

Initially, an evaluation must be undertaken to determine whether or not a material is potentially air-reactive. If a material is potentially air-reactive, the inventory information for each item is reviewed to determine whether it can safely be handled under atmospheric conditions in existing facilities or if it needs to be handled in an inert atmosphere, which will require processing in a new inert glovebox that is being installed in an ORNL laboratory facility. If an inert atmosphere is not required, the material is stabilized, packaged, and staged in existing facilities for programmatic use if a user can be identified or packaged for disposal as waste if no programmatic user is identified.

If an inert atmosphere is required, the material is stored until it can be processed in the new inert glovebox that has just recently become operational. Once the material is in the inert glovebox, it will be examined to determine if it is of value to programmatic users in its present air-reactive state. If it is determined to have programmatic value, the material will be repackaged in containers approved for the storage of reactive materials and staged. If the air-reactive material is determined to not be of programmatic value in its reactive state, it will be stabilized and handled as nonreactive material. The stabilization process for air-reactive materials includes steps to dissolve and assay the materials, dry or calcine the material, and stage the material in ORNL-approved storage containers.

DISCUSSION

The management plan for high-value and potentially air-reactive materials at ORNL has been implemented. The items that could be safely handled outside an inert glovebox environment have been processed and distributed to programmatic users. For example, a recent project consolidated and distributed 200 g >82% enriched ^{242}Pu to DOE programmatic users. A limited inventory of potentially air-reactive materials has remained in storage awaiting an inert glovebox processing facility to become operational.

A new inert glovebox has been designed and constructed for management of air-reactive materials and has recently been installed in an ORNL laboratory facility (see Figures 3 and 4). Items that require processing in an inert environment are beginning to be processed.

Figure. 1. Approach developed for managing high-value and potentially air-reactive materials at ORNL.

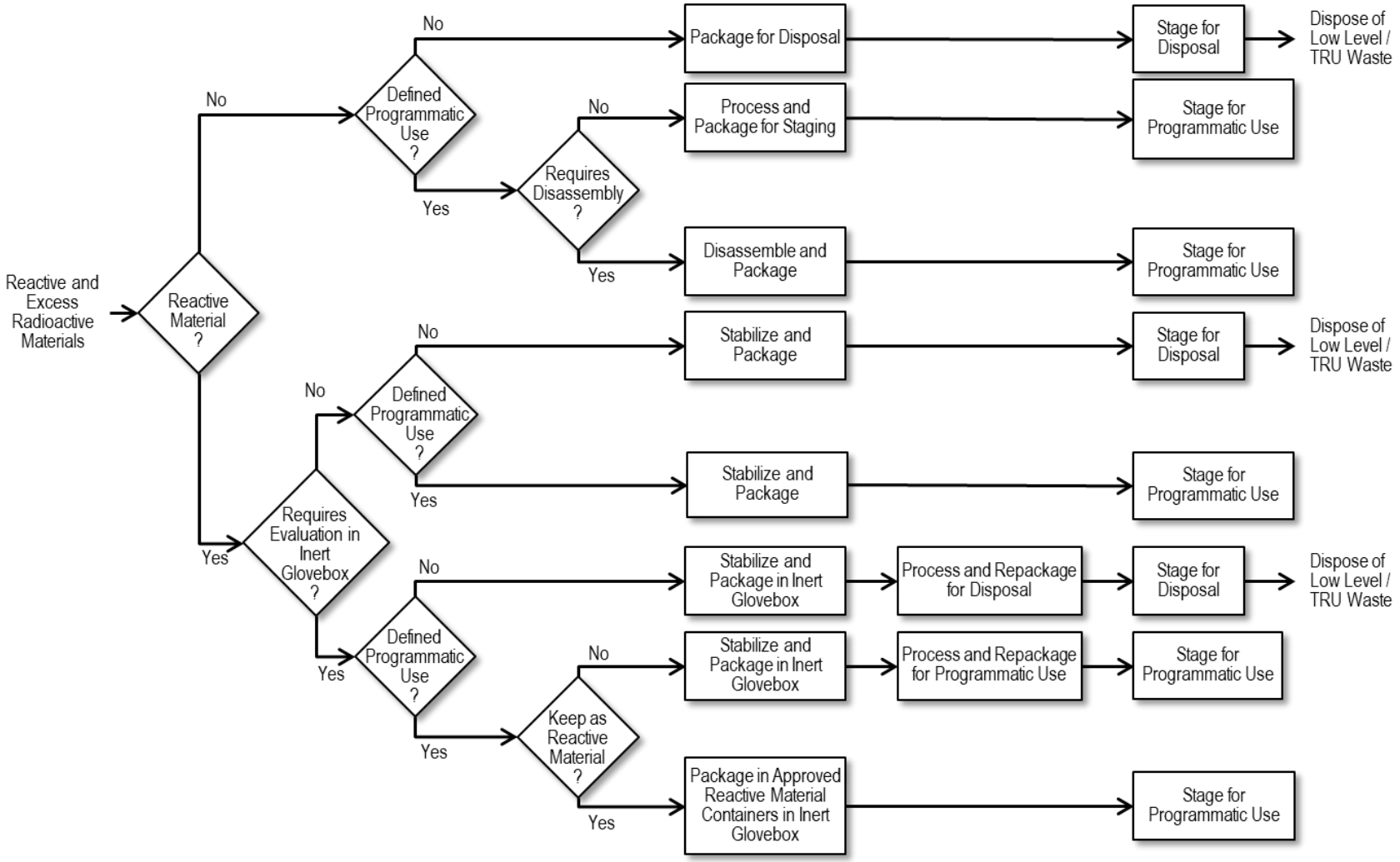

Figure 2. Implementation approach used for managing ORNL's potentially air-reactive material.

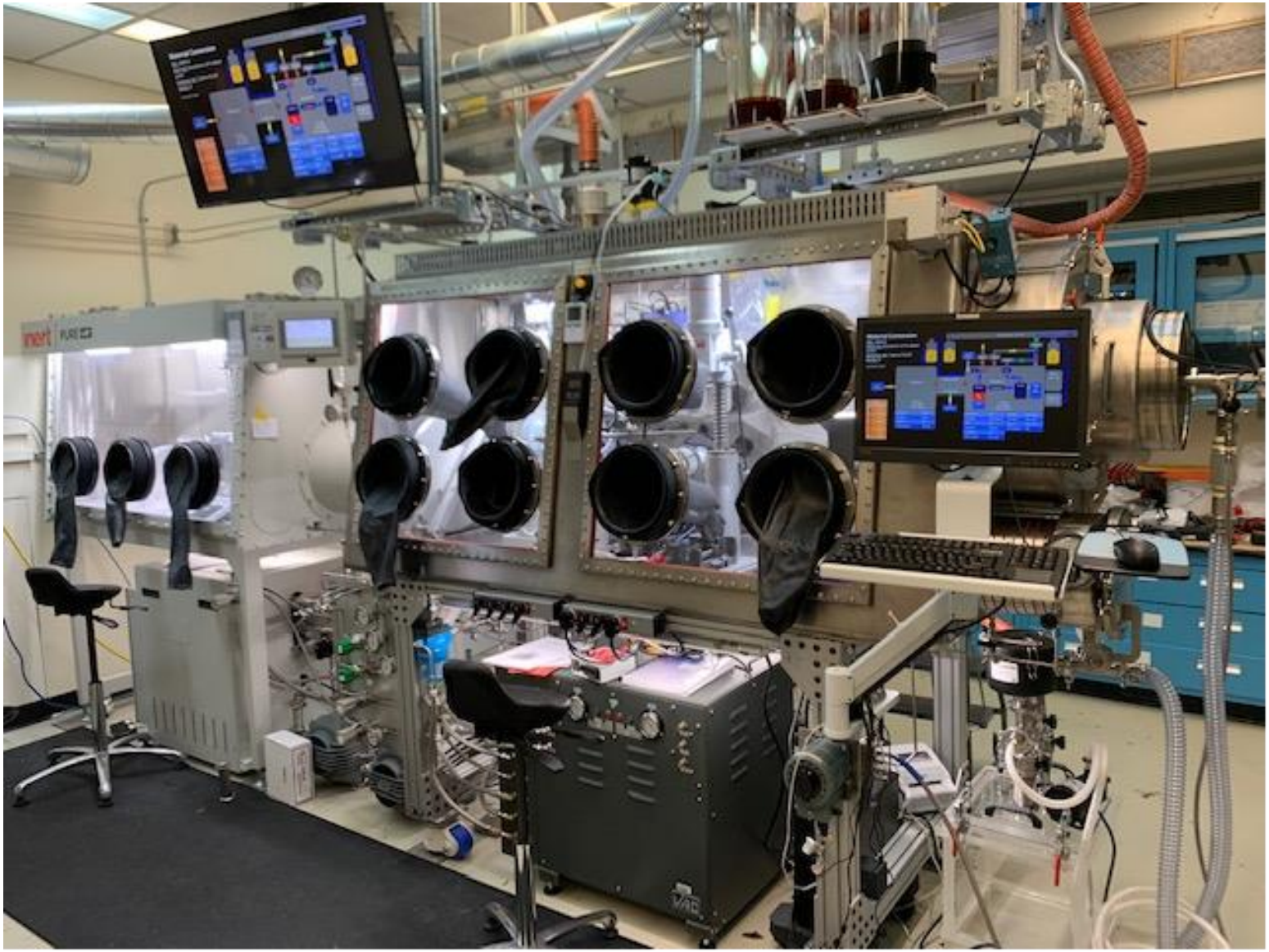

Figure 3. Inert glovebox for evaluating, stabilizing, and repackaging air-reactive material.

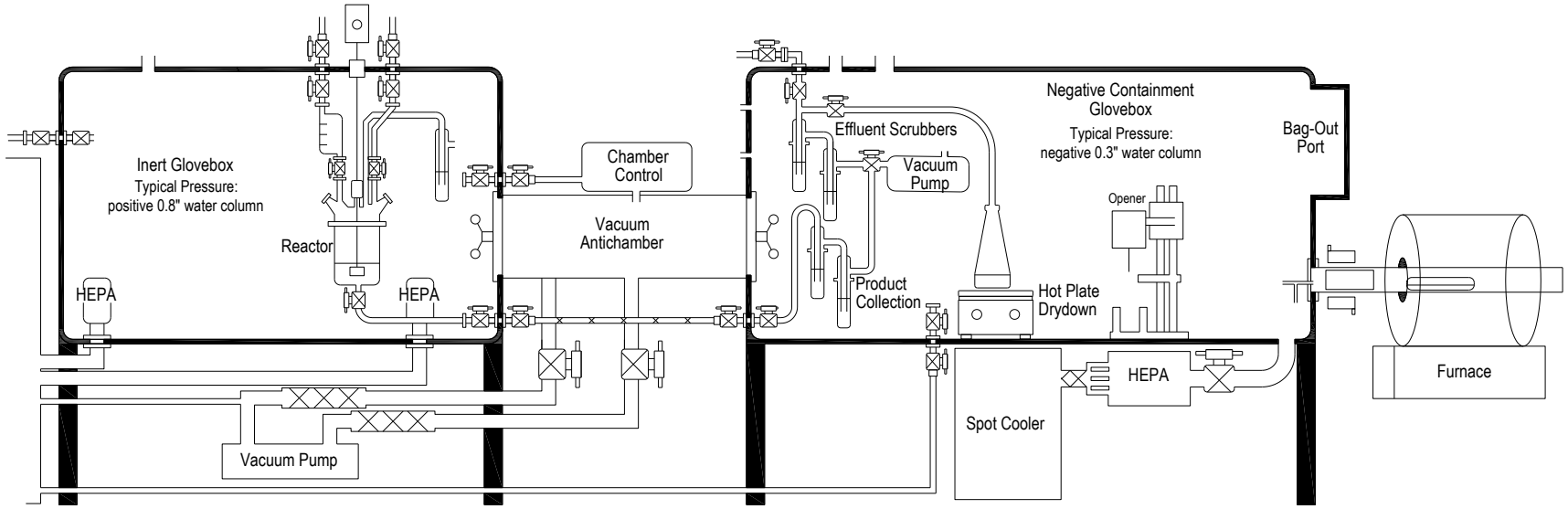

Figure 4. Conceptual design of an inert glovebox for evaluating, stabilizing, and repackaging air-reactive material.

Potentially high-value air-reactive materials will be examined in the new inert glovebox and will be characterized, stabilized, repackaged, and distributed as appropriate. The data gained through the examination of the materials will be used to transfer as many of the items as possible to defined uses and to end users.

A unique inventory of potentially air-reactive high-purity (mostly metal) U, Pu, Am, and Np materials will be retrieved from storage and examined in a negative-pressure inert glovebox. If the metal samples are in a useful condition, they will be repackaged in inert shipping containers standardly used by the DOE Office of Science Isotopes Sales Program and transferred to programmatic users in their original condition. An example of a storage container presently used at ORNL by the DOE Office of Science Isotope Program to stage and ship reactive material to customers is shown in Figure 5. The high-vacuum stainless steel components along with copper gaskets provide a heavy-duty, rugged container required for shipping and long-term storage of air-reactive metals.

If necessary, the materials will be stabilized. The stabilization process includes dissolution, assay, drying/calcining, and staging in ORNL approved storage containers for distribution to users or dispositioned as waste if the items are determined to be unusable. Potential programmatic users include defense programs, the DOE Office of Science Isotope Program, National Nuclear Security Administration nonproliferation detection programs, and the DOE Office of Nuclear Energy.

If the material is determined to not be of programmatic value in its reactive state, then it is stabilized and packaged for staging for programmatic use or disposal as waste. The stabilization process for reactive materials includes steps to dissolve (passivate or oxidize) and assay the materials. If the material is not expected to be used by a user program immediately, then it is dried or calcined and staged in ORNL-approved storage containers.

Many of the materials to be examined in the inert glovebox have been in storage for many years. Examples are shown in Figure 6. Two items containing highly enriched uranium metal foils that were small enough to be opened in a laboratory are shown in Figure 7.

CONCLUSIONS

ORNL has an inventory of radioisotopes that have been held for reuse because they were believed to have potential intrinsic value to DOE, but many of these materials have no currently defined use. ORNL is undertaking an initiative to more actively address the management of these materials. The existing inventory is being reviewed to determine if the contents have programmatic use. Steps are being taken to process the materials, repackage them, and stage as many of them as possible for distribution to programmatic users. As a last resort, steps are being taken to process the materials for waste disposal.

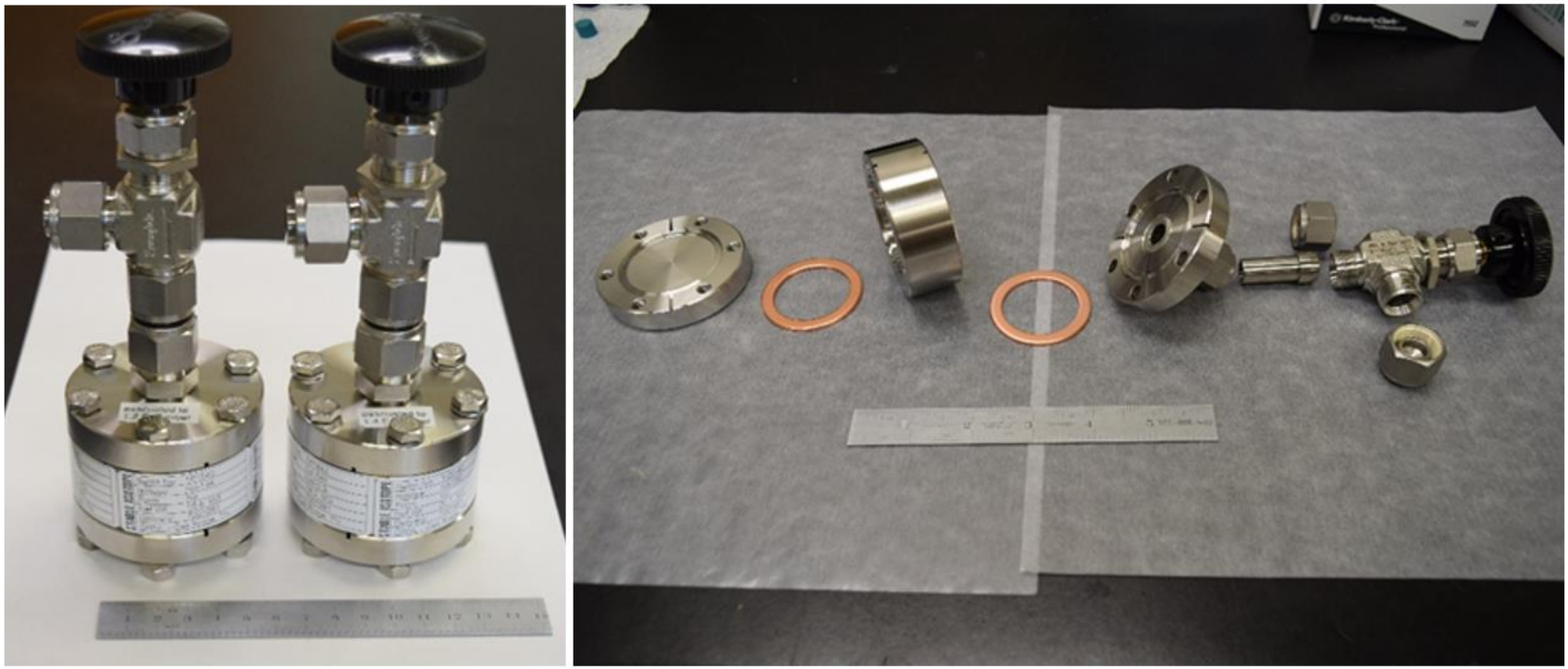

Figure 5. *Left*, fully assembled reactive metal shipping containers. *Right*, unassembled vacuum components.

Figure 6. Potentially air-reactive items to be examined in an inert glovebox.

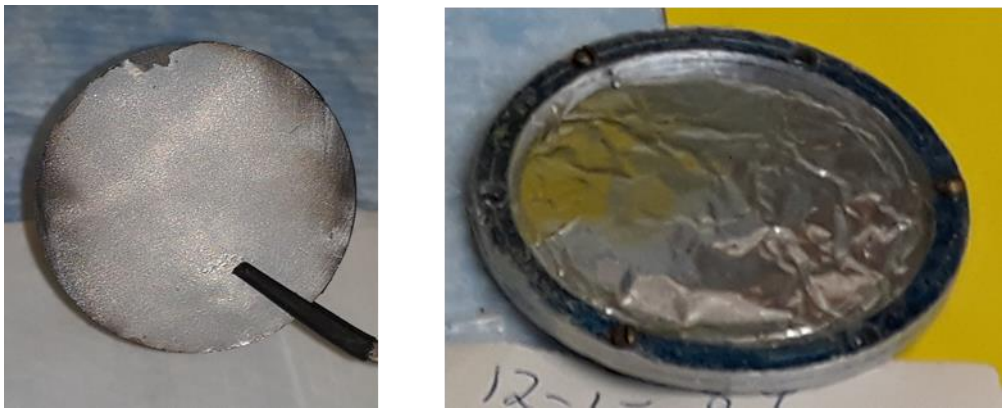

Figure 7. Recovered highly enriched uranium metal foils.

ACKNOWLEDGMENTS

This work was funded by the National Nuclear Security Administration's Nuclear Materials Integration Office.

REFERENCES

1. B. D. Patton et al., "Heavy Isotopes Lead Material Management Organization Update," *INMM 55th Annual Meeting,* Atlanta, Georgia, July 20–24 (2014).
2. S. M. Robinson et al., "Evaluation of Options for Disposition Mk-42 Materials," *WM2018 Conference,* Phoenix, Arizona, March 18–22 (2018).