

Global Threat Reduction Initiative Efforts to Address Transportation Challenges Associated with the Recovery of Disused Radioactive Sealed Sources¹

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ABSTRACT

The Global Threat Reduction Initiative's Off-Site Source Recovery Project (GTRI/OSRP), faced with decreasing availability of certified transportation containers to support movement of disused and unwanted neutron- and beta/gamma-emitting sources, has initiated actions to ensure the continued success of the project in timely recovery and management of sealed radioactive sources. Efforts described in this paper include:

- Addition of authorized content to existing and planned Type B containers to support the movement of Type B quantities of sealed sources.
- Procurement of vendor services for the design, development, testing, and certification of a new Type B container to support transportation of irradiators, teletherapy heads, or sources removed from these devices using remote handling capabilities such as the IAEA portable hot cell facility.
- Expansion of shielded Type A container inventory for transportation of gamma-emitting sources in activity ranges requiring use of shielding for compliance with transportation requirements.
- Approval of the S300 Type A fissile container for transport of Pu-239 sealed sources internationally.
- Technology transfer of field-sealable (non-welded) special form capsules for commercial use.

GTRI is also undertaking efforts to enhance the security of GTRI/OSRP shipments. A dedicated vehicle, equipped with real-time tracking, improved communications, and driver duress capabilities has been acquired. Additional security technologies are being evaluated for reliability and performance. These features may be added to the vehicle if they are demonstrated to be effective. This paper will also summarize these security measures and how they are being used to improve the overall security of GTRI/OSRP shipments.

¹This paper represents the views of the authors, but does not necessarily reflect their respective agencies' or organizations' positions.

INTRODUCTION

Without affordable and timely transportation options, disused sealed sources remain in storage at hundreds of sites throughout the country and around the world. While secure storage is a useful temporary measure, the longer sources remain unwanted, the chances increase that they will become unsecured or abandoned. GTRI/OSRP recovers thousands of disused and unwanted sealed sources annually as part of GTRI's larger mission to reduce and protect high-risk nuclear and radiological materials located at civilian sites worldwide.

BACKGROUND

GTRI/OSRP has averaged about 70 transports per year over its ten-year history, of which about 28% are defined as Category 1 or 2 shipments². GTRI/OSRP has worked extensively to develop packaging configurations that conform to regulatory requirements for material transportation. This includes developing field-sealable special form capsules (that do not require welding) and obtaining a competent authority certification for the S300 pipe overpack container³ as a Type A fissile container for domestic and international use.

In addition to Type A containers for actinide sources, GTRI/OSRP used the 6M specification Type B container and the Frontier water extended poly (WEP) Type A container, depending on the items to be transported. Since 2004, GTRI/OSRP has also been tasked with recovering higher activity sources of various isotopes that require Type B containers for shipment.

The expiration of U.S. Department of Transportation (DOT) specification Type B containers such as the aforementioned 6M and the 20 WC container (Figure 1) on October 1, 2008, created difficulties for GTRI/OSRP recovery efforts because GTRI/OSRP and their subcontractors relied heavily on these types of general-use containers to ship sources for threat reduction purposes.



Figure 1: Specification 20WC Type B Containers Formerly Used by GTRI/OSRP Subcontractors

² For definition of categories, see IAEA-TECDOC-1344, “Categorization of Radioactive Sources” (http://www-pub.iaea.org/MTCD/publications/PDF/te_1344_web.pdf).

³ U.S. Department of Transportation Competent Authority Certification for A Type Fissile Radioactive Materials Package Design Certificate No. USA/9329/AF-96, Rev. 2 (<http://rampac.energy.gov/certificates/1039329.PDF>).

While the problems are most serious for very high activity sources and large, heavily shielded devices, they are also very real for smaller actinide sources that may no longer be special form and that exceed A_2 quantities⁴. For example, a 30 mCi (1.11GBq) Am-241 sealed source must be transported in a Type B container if it cannot be shown to meet the special form requirements. Expiration of special form status is a very common problem in the U.S. (and internationally), causing even low-hazard sources to become difficult or impossible to transport in accordance with applicable standards and regulations in their existing configuration, especially when in gauges or other devices.

Although GTRI/OSRP maintains a list of special form certificates on its webpage (osrp.lanl.gov) and some manufacturers have exemptions or special permits for domestic shipment of gauges that may contain sources with expired certificates, many sources are not covered by either of these contingencies.

ADDITION OF SEALED SOURCE CONTENT TO EXISTING TYPE B CONTAINERS

Prior to the expiration of the authorization for specification Type B containers, GTRI/OSRP used specification 6M containers to transport sources to central storage locations to consolidate them prior to disposal, especially where special form certificates were no longer current. GTRI/OSRP generally consolidates sealed sources to maximize disposal efficiency. Some qualified source owners also used 6M containers to “self-ship” sources to GTRI/OSRP consolidation facilities, with GTRI/OSRP assistance.

After October 1, 2008, GTRI/OSRP applied for and received a DOT special permit (SP-14797)⁵ authorizing GTRI/OSRP to continue the use of “designated DOT specification 6M packagings after October 1, 2008, in order to allow the grantee a transition period to performance oriented package use.” By this time, GTRI/OSRP had already identified a suitable replacement container (Figure 2), the 9977 Type B(M)F container developed by the Savannah River National Laboratory (SRNL).



Figure 2: The Older 6M Components and Newer 9977 Type B Containers

⁴ The Table of A_1 and A_2 values for radionuclides is provided in 49 CFR 173.435 (http://edocket.access.gpo.gov/cfr_2008/octqtr/pdf/49cfr173.435.pdf).

⁵ U.S. Department of Transportation Special Permit No. DOT-SP 14797, First Revision (http://www.phmsa.dot.gov/staticfiles/phmsa/spa_app/offerdocuments/sp14797_2009030508.pdf).

However, the content envelope for this container had to be modified to accommodate GTRI/OSRP's sealed source-specific content. The DOT special permit expired on February 28, 2010, by which time GTRI/OSRP and SRNL completed efforts to modify the 9977 Safety Analysis Report for Packaging (SARP) and certificate of conformance⁶ to account for GTRI/OSRP shipping needs. However, GTRI/OSRP applied for an extension to the special permit until May 2010, because it was unable to obtain assembled 9977 containers before that date.

The 9977 Small Gram Quantity (SGQ) amendment that added GTRI/OSRP sealed sources to the allowable content was reviewed by Department of Energy's (DOE) Office of Environmental Management (EM) Packaging Certification Program (PCP), EM-45. The amendment proposed that smaller gram quantities of radioactive material (consistent with the sealed sources GTRI/OSRP needs to transport) create less risk, especially when below the de minimis mass for criticality, and that the main parameter of interest that could be challenged by such contents is external dose rate.

Three pre-approved shielded inner containers were designed by SRNL to address dose rate concerns; the amendment language proposes that maximum dose rates be measured on the surface of these inner containers prior to placement in the external package. [1]

Dr. Jim Shuler, the DOE PCP Manager, and Steve Bellamy and Glenn Abramczyk at SRNL have provided essential assistance in this effort.

DEVELOPMENT OF A DOE-OWNED TYPE B CONTAINER

The issues with availability of Type B containers affect both domestic and international recovery operations. In addition to prioritized domestic recovery of high-activity sources and source-containing devices, GTRI/OSRP conducts threat reduction missions internationally. This occurs both under bilateral agreements between the U.S. and individual countries, and in coordination with the Waste Technology Section of the International Atomic Energy Agency (IAEA). This coordination includes joint recovery missions in IAEA member states as a part of an IAEA team; and participation in resource development efforts supporting related IAEA work in member states, such as providing training and supporting development of the International Catalogue of Sealed Radioactive Sources.

The lack of certified Type B containers both domestically and abroad, as well as their limited allowable content (e.g., many are device-specific, despite the assortment of different device models in use or in storage), restriction from use for transporting non-special form sources, and high operational costs have created a significant barrier toward fulfilling proper end-of-life management of critical equipment such as blood irradiators and cancer treatment devices.

One of the major areas of GTRI/OSRP coordination with the IAEA has been in the development of a transportable hot cell⁷ for use in removing high activity sources from devices (Figure 3), with consolidation of sources into a secure shield assembly (called the Long-term Storage Shield, or LTSS) for subsequent recovery or secure storage.

⁶ U.S. Department of Energy Certificate of Compliance for Radioactive Materials Packages No. USA/9977/B(M)F-96 (<http://rampac.energy.gov/certificates/1029977-ST1.PDF>).

⁷ For more information about this transportable hot cell, see IAEA Fuel Cycle and Waste Newsletter Vol. 3, No. 2 (<http://www-pub.iaea.org/mtcd/publications/pdf/newsletters/nefw-03-02.pdf>); and the IAEA Bulletin Volume 49, Issue 1 (<http://www.iaea.org/Publications/Magazines/Bulletin/Bull491/pdfs/49102685658.pdf>).



Figure 3: IAEA Portable Hot Cell Facility and LTSS
(Source: www.iaea.org/Publications/Magazines/Bulletin/Bull491/49102685658)

Originally, there was virtually no opportunity for repatriation and/or disposal of sealed sources removed from old devices, so it was not a priority for IAEA to license the LTSS as a transport container. However, in recent years, more opportunities for source repatriation have materialized and the ability to transport the loaded LTSS would improve IAEA options for managing sources that might previously have been placed into secure long-term storage onsite. GTRI, after careful review and in consultation with the IAEA and international colleagues, decided to pursue the development of a Type B container designed specifically to work with the LTSS.

Major factors in this decision included:

- Threat reduction benefits gained from movement of sources via repatriation from storage location to country of origin or manufacturer.
- Flexibility to transport the Type B container to multiple locations following loading in the field for source consolidation.
- Potential for use of Type B container to transport other devices/containers in addition to the LTSS.

Experience gained through ten years of GTRI/OSRP operations has shown that the flexibility desired by GTRI/OSRP could only be ensured if the DOE owned its own Type B container and certification. Thus, the decision was made to pursue design, fabrication, testing, and certification of a Type B container that would accommodate the LTSS, as well as many other high-activity source-containing devices in commercial use domestically and around the world. Once fabricated and available for use, GTRI/OSRP hopes to make the container available to contractors for use in executing recovery operations for threat reduction purposes.

The intent is not to replace commercial contractors for these recovery actions, but to augment the limited packaging capabilities available in the commercial arena today, which is resulting in slower-than-desired rates of recovery. It is hoped that having such a Type B container available in the overall limited market will reduce costs to domestic source/device owners, who cannot currently afford the tens or hundreds of thousands of dollars necessary to transport their devices to a secure storage location.

After a competitive bidding process, GTRI/OSRP awarded a contract in late September 2009 to design, test, and certify a new Type B container. Work was initiated in November 2009 and GTRI/OSRP anticipates availability of the container in two to three years.

EXPANSION OF SHIELDED TYPE A CONTAINER INVENTORY FOR TRANSPORTATION OF HIGHER-DOSE SOURCES

In managing the recovery and disposal of beta- and gamma-emitting sources that can be shipped in Type A containers (e.g., up to 0.6 TBq of Cs-137 if not special form, or 0.4 TBq for Co-60 sources), GTRI/OSRP and source owners have numerous container types and manufacturers to choose from.

GTRI/OSRP worked with commercial device manufacturers who manage these types of sources for advice on which container to use. Several manufacturers recommend the use of Type A shielded casks. While the availability of Type A containers is a much preferred reality to the insufficient Type B container situation, without appropriate planning and selection of specific types of containers (especially related to payload cavity dimensions and shielding) for specific applications, it can complicate consolidation and disposal activities once sources are recovered.

Options must be evaluated to ensure selection of the most cost effective and ALARA-cognizant packaging methods for the sources to be recovered, consolidated, and disposed.

- Recoveries can typically be achieved by using different models of Type A containers with minimal or no shielding needed, as the inventory of sources at a single facility is usually not restrictive. This allows the flexibility for standardization of packaging to a few types of containers for consolidation and repackaging for disposal.
- The Waste Acceptance Criteria (WAC) for available disposal facilities influences the selection of Type A packages for disposal. In many cases, the activity content of each container is very limited; and the use of standard 55-gallon drum configurations with shielding is most appropriate. In other cases, the specific packaging requirements may be a strict requirement of the disposal facility WAC. If large numbers of sources falling into these categories are known to be awaiting disposition, this can dictate the need for specific packaging availability.
- In cases where sources can be consolidated into payloads with a much higher total activity such that shielding is required for conformity with disposal facility or transportation limits, shielded Type A containers are available.

Experience has shown that use of standardized packaging configurations:

- Simplifies the waste certification processes at available disposal facilities as the certification staff at the facilities see fewer variables to evaluate.
- Reduces the potential for human errors in the field since options are narrowed. Processes and procedures are simplified and decreased; and training and qualification requirements are also reduced.
- Allows for identification and utilization of economies-of-scale offered in procurement actions if more containers of fewer types are procured.

GTRI/OSRP is currently using shielded Type A containers for recoveries and for some disposal activities.

At least one vendor has been added to Los Alamos National Laboratory's (LANL) approved list of vendors and several off-the-shelf containers have been ordered, as well as design of a customized container to hold GTRI/OSRP's mid-range Model III special form capsule, which is frequently used for the recovery of Ra-226 sources.

OSRP has also worked with container manufacturers to review and expand the isotopes listed for use in off-the-shelf configurations and design different inserts to stabilize and/or shield the sources being packaged. One manufacturer was able to approve the use of its containers for an expanded

list of isotopes and different packaging inserts, although its review indicated that not all of the isotopes could be loaded to Type A limits due to high dose rates (alternative statistically-based loading limits were provided).

APPROVAL OF THE S300 CONTAINER FOR INTERNATIONAL TRANSPORT OF PU-239 SEALED SOURCES

Although GTRI/OSRP has obtained a Competent Authority Certification (CAC) for the S300 Type A Fissile container from DOT, the container is of limited use in GTRI/OSRP's efforts to repatriate U.S.-origin Pu-239 sealed sources because of domestic regulations restricting air transport of plutonium within the U.S.⁸ This limitation has resulted in delays in the repatriation of packaged U.S.-origin plutonium sources and hinders threat reduction activities. GTRI/OSRP is currently working on an amendment to the Safety Analysis Report (SAR) for the S300 that will specifically address requirements for air transport of Pu-239 sealed sources in other countries under international air shipping regulation. However, these changes will not solve the statutory limitation of air shipment of plutonium into or within the U.S.

The rationale for the SAR change is that the container content is sufficiently limited so that the Pu-239 source contents can in no way become critical, even under the most severe hypothetical accident conditions. If the changes are approved, the S300 SAR would more clearly specify its ability to move U.S.-origin Pu-239 sources from one country to another by air. This ability improves the efficiency of Pu-239 source repatriation efforts. For example, an S300 shipped by air from one land-locked nation to a coastal nation for loading onto a GTRI-funded maritime transport may be preferable (in some cases) to overland transport over harsh terrain or across unsecure territory.

TECHNOLOGY TRANSFER OF SPECIAL FORM CAPSULES

Early in its ten-year history, GTRI/OSRP developed stainless steel capsules to encapsulate radioactive sealed sources in the field, making them special form by mechanical means without welding (Figure 4). GTRI/OSRP has used this innovation hundreds of times in the field when recovering disused sealed sources, particularly for actinides, whose A_2 value can be as low as 27 mCi (0.001 TBq). The capsules have potential commercial interest, judging by requests GTRI/OSRP has received to provide training on their use and proper closure to potential commercial users. Among other things, they have proven useful in packaging Ra-226 sources, both because these tend to leak at weld points and because the A_2 value for older, usually non-special form sources is only 81 mCi (0.003 TBq), so that a Type B container is required for sources with greater activities, unless converted to special form.



Figure 4: GTRI/OSRP Model II and III Special Form Capsules, Closure

⁸ See U.S. Nuclear Regulatory Commission, 10 CFR 71.88, titled "Air transport of plutonium" (http://edocket.access.gpo.gov/cfr_2009/janqtr/pdf/10cfr71.88.pdf).

GTRI/OSRP is working through LANL's Technology Transfer program to identify vendors potentially interested in manufacturing and distributing these field-sealable special form capsules commercially. GTRI/OSRP also assisted QSA Global in obtaining a Certificate of Competent Authority for similar capsules⁹.

TRANSPORTATION SECURITY IMPROVEMENTS

GTRI is implementing new requirements to enhance the security of GTRI/OSRP shipments that exceed existing regulatory requirements. A dedicated vehicle has been procured by Oak Ridge National Laboratory for use by LANL in GTRI/OSRP recovery operations that is equipped with real time tracking (via the DOE Transportation Tracking and Communications System, TRANSCOM). The tracking system provides improved communications such as text messaging to and from the driver and driver duress alarm capabilities. Delay features will soon be installed on the vehicle in the form of security overpacks that are highly resistant to penetration and which cannot be readily removed from the vehicle. Additional security technologies are being evaluated for reliability and performance and will be added to the vehicle if they are demonstrated to be effective. Capabilities being evaluated include: cargo area intrusion detection; door open/closed sensors; and, electronic door and package seals.

For subcontracted shipments (such as those requiring use of open transport vehicles due to larger container sizes), GTRI is also evaluating enhanced transportation security measures intended to provide a level of security exceeding existing regulatory requirements. Such measures may include delay features to prevent removal of packages from the vehicle and electronic detection of attempted unauthorized removal of the package or access into the package. Other elements of a carrier's security program, such as detailed planning and procedures for response, must be at least equivalent to the regulatory requirements.

CONCLUSIONS

GTRI/OSRP is working on many fronts to improve source recovery transportation operations, from regulatory conformance and efficient design to transportation security. Rather than seeking special permits and special international arrangements for the many tens of GTRI/OSRP shipments conducted each year, GTRI/OSRP seeks to transport radioactive materials safely, securely, and in a manner that meets or exceeds regulatory requirements using both commercial and government assets as available.

ACKNOWLEDGMENTS

This work was funded through NNSA's Office of Global Threat Reduction (NA-21). The authors wish to thank and acknowledge members of GTRI/OSRP at Los Alamos National Laboratory; DOE Package Certification Program Manager Dr. Jim Shuler and his support staff; Steve Bellamy, Glenn Abramczyk, and other staff at SRNL; and members of the Transportation Technologies Group and Global Nuclear Security Programs Office at Oak Ridge National Laboratory for their support and technical assistance regarding these challenges.

⁹ U.S. Department of Transportation Certificate of Competent Authority for Special Form Radioactive Materials Certificate No. USA/0695/S-96, Rev. 4 (<http://rampac.energy.gov/certificates/1030695.PDF>) and Certificate No. USA/0696/S-96, Rev. 4 (<http://rampac.energy.gov/certificates/1030696.PDF>).

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