GLOBAL THREAT REDUCTION
SOURCE RECOVERY EFFORTS IN LATIN AMERICA

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ABSTRACT

The Global Threat Reduction Initiative's Off-Site Source Recovery Project (OSRP), which is administered by the Los Alamos National Laboratory (LANL), removes excess, unwanted, abandoned, or orphan radioactive sealed sources that pose a potential risk to health, safety, and national security. This program traditionally addressed domestic threat reduction efforts within the United States. Since May 2004, the scope of the OSRP has expanded to recovering not only domestic sources, but also disused and unwanted U.S.-origin radioactive sealed sources internationally. As of October 2008, OSRP has recovered over 18,664 excess and unwanted sealed sources totaling over 712,958 curies of activity. This paper provides a synopsis of cooperative efforts in Latin America to remove sealed sources by discussing four topical areas: 1) Bilateral initiatives with Ecuador and Chile; 2) The Latin American Regional Partnership with the International Atomic Energy Agency; 3) Challenges in repatriating sealed sources; and 4) Future cooperation.

OVERVIEW OF OFF-SITE SOURCE RECOVERY PROJECT

The Off-Site Source Recovery Project (OSRP), under the Global Threat Reduction Initiative (GTRI), recovers and manages excess and unwanted radioactive sealed sources (sources) that present a risk to public health and safety and for which few or no disposal options currently exist. Since 1999, OSRP has recovered more than 18,664 sources from over 700 sites (including all 50 states, the D.C. area, Puerto Rico and a number of foreign countries) totaling over 712,958curies of activity.

Radioactive sources are used in medicine, industry, agriculture, academic, and government facilities for a variety of purposes. Since the 1960s, under the premise of the Atoms for Peace program, radioactive sealed sources have been supplied to institutions worldwide by the U.S. government and private companies have sold and donated radioactive sources and source-containing devices in commerce to promote the peaceful uses of nuclear technology. In the U.S., until a disposition pathway is determined, disused sources are placed in short-long-term storage facilities. However, in many countries, some disused sources have been abandoned or are

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placed in facilities that are often improperly maintained and poorly guarded. These types of at-risk sources have the potential to be stolen and used for malicious purposes. Currently, there are tens of thousands of locations worldwide storing radioactive sources. Many of these sources pose a proliferation threat and could be readily employed for use in a radiological dispersal device (RDD) less formally known as a dirty bomb.

Figure 1: Disused and Unwanted sources

Since May 2004, OSRP has adjusted its scope to include an increasing number of isotopes and has expanded the breadth of its recoveries to include U.S. origin sources in other countries. OSRP, therefore, was provided with new direction to expand its mission abroad – that is, to identify, assess, and repatriate U.S.-origin radioactive sealed sources from foreign countries. The recovery of sealed sources from foreign countries initially focused on recovering Pu-239 neutron sources provided by the Department of Energy (DOE) (Formerly known as the Atomic Energy Commission), under the auspices of the Atoms for Peace Program, to approximately 30 countries in the 1960s. International recoveries have now progressed far beyond the original limited scope. The scope of this program now includes isotopes that present substantial safety and security risks, more specifically isotopes which the DOE is responsible for disposing of in the United States: Plutonium-238, Plutonium-239, Americium-241, Californium-252, Curium-244, Strontium-90, Cesium-137, Cobalt-60, Irridium-192, Radium-226. GTRI is now implementing sealed source repatriation to the country of origin as an alternative to physical security upgrades at waste storage facilities on a case-by-case basis.

INTRODUCTION

Over the last year, several countries in Latin America were identified as candidates for repatriation exercises and have since requested assistance to remove these materials. Although a few countries may be trying to develop permanent disposal sites for radioactive materials, currently, none of the governments in the region have created a permanent disposition site for sources (especially the longer-lived actinide radionuclides). Bilateral and multilateral source repatriation operations have been carried out successfully, thus demonstrating the value and feasibility of source repatriation and in securing international cooperation in support of this novel effort. This paper provides a synopsis of past and current cooperative efforts in Latin America to

remove sealed sources by discussing four topical areas: 1) Bilateral initiatives with Ecuador and Chile; 2) Multilateral efforts through the Latin American Regional Partnership and the International Atomic Energy Agency (IAEA); 3) Challenges in source repatriation; and 4) Future cooperation.

BILATERAL INITIATIVES WITH ECUADOR, CHILE, AND PERU

Bilateral sealed source recovery efforts in Latin America began in December 2006 when GTRI received an unofficial source inventory from the former Ecuadorian Atomic Energy Commission (CEEA).[1] The inventory contained information on each isotope such as the level of activity, manufacturer, and serial number. After an initial examination of the inventory, a small OSRP team traveled to Quito, Ecuador, to conduct an assessment of the sources in storage. The purpose of an assessment is to verify the inventory, identify precisely which sources would be managed and repatriated to the U.S., and collect any additional information that may have been absent when the inventory was initially provided. In June 2007, a GTRI/OSRP team returned to Ecuador and conducted a special form re-encapsulation and packaging of 35 sources.[2]

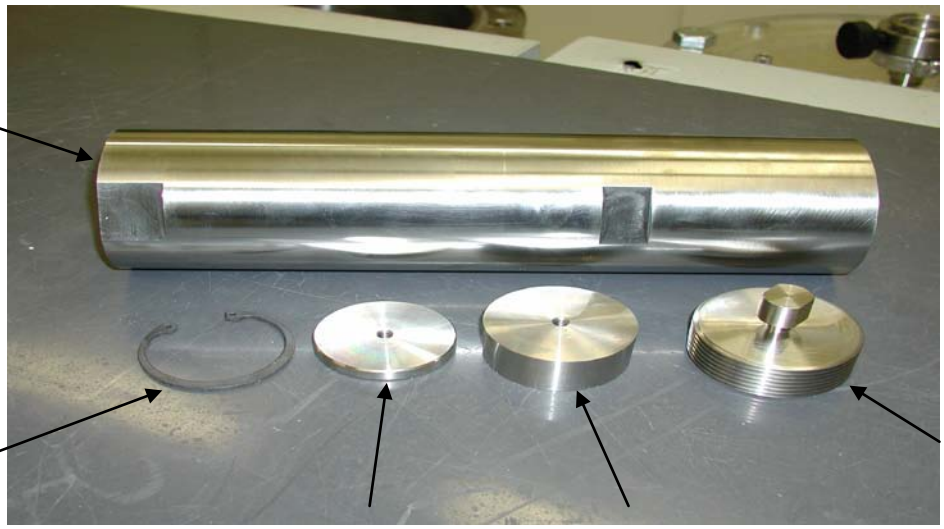

Figure 2: Special Form Capsule

[1] As of January 2008, the Ecuadorian Atomic Energy Commission was dissolved by Presidential Decree and placed under the Ecuadorian Ministry of Electricity and Renewable Energy. Cooperation with GTRI continues under the Ministry.

[2] According to Title 49 of the Department of Transportation's Code of Federal Regulations, the definition of special form is the following: *Special form Class 7 (radioactive) material* means either an indispersible solid radioactive material or a sealed capsule containing radioactive material which satisfies the following conditions: (1) It is either a single solid piece or a sealed capsule containing radioactive material that can be opened only by destroying the capsule; (2) The piece or capsule has at least one dimension not less than 5 mm (0.2 in); and (3) It satisfies the test requirements of §173.469. Normal or Other Form applies to radioactive materials outside the scope of special form.

In 2007, these 35 sources and an additional 48 sources belonging to and packaged by a source/device manufacturer called Schlumberger, were all repatriated to the U.S.

Also in 2007, a second bilateral sealed source recovery project in Latin America began with GTRI offering to remove all U.S.-origin sealed sources that were currently stored in Chile. Using the data collected from an initial assessment, GTRI and OSRP prepared a tentative work plan to recover over300 U.S.-origin sealed sources with varying isotopic compositions, such as Ra-226 (Radium), Cs-137 (Cesium), Co-60 (Cobalt), Am-241 (Americium), and Sr-90 (Strontium).

In 2008, the GTRI/OSRP team traveled to Santiago, Chile, to package the materials identified for repatriation. Packaging occurred on-site for several days, which involved the disassembly of many source-containing devices and removal of higher activity sources from storage shields (Figure 2). The team packaged 430 U.S.-origin sealed sources, but avoided packaging the higher-activity medical devices used in cancer treatments, due to complexities of international transport, high costs, and low availability of the appropriate containers (Type B) that would be required for shipment of such materials. These packaged high-activity sources have yet to be returned to the U.S. and are currently stored in shipping containers. GTRI is planning to coordinate the removal of these difficult to manage sources by potentially adding them onto future shipments of spent nuclear fuel from the region. This would alleviate a couple of the abovementioned difficulties in shipping high-activity sources internationally and especially between continents.

Figure 2: Removing Ra-226 brachytherapy source from storage shield in Chile.

A small team from GTRI has also recently conducted an assessment of the U.S.-origin disused radioactive sealed sources in Peru. The storage facility is located at the RACSO Nuclear Research Center, located roughly 45 miles outside of Lima. It was determined that numerous sources are eligible for repatriation. GTRI will continue to work with the Peruvian Institute of Nuclear Energy to plan for the eventual packaging and repatriation of the sources.

LATIN AMERICAN REGIONAL PARTNERSHIP WITH THE INTERNATIONAL ATOMIC ENERGY AGENCY

GTRI has joined with the IAEA and the U.S. Department of State in a Latin American Regional Partnership to identify, condition, and dispose of disused and unwanted sources. This activity is funded by the Nonproliferation and Disarmament Fund (NDF) at the State Department, as well as in-kind contributions from GTRI. The scope of the Latin American regional partnership is intended to address radioactive sealed sources in five countries: Argentina, Brazil, Colombia, Uruguay, and Venezuela. Project implementation is coordinated with the IAEA Division of Nuclear Fuel Cycle and Waste Technology and the IAEA Office of Nuclear Security. The U.S. is pursuing the Latin American Regional Partnership as a pilot program to reduce the number of unwanted and disused radioactive sources that could be used by terrorists for malicious purposes, such as a RDD. The first objective of this project is to repatriate excess and unwanted U.S.-origin plutonium/beryllium (PuBe) neutron sources. The second objective is to demonstrate the feasibility of cooperative efforts to return unwanted, vulnerable radiological sources to their country of origin or to the United States for secure storage and disposition.

In support of this project, the Brazilian National Nuclear Energy Commission (CNEN) also signed a Terms of Reference (TOR) with the IAEA whereby they agreed to play a significant role in this project by acting as a regional consolidator under the Latin American Regional Partnership. The Government of Brazil agreed to allow temporary importation of radioactive materials into Brazil from nearby countries with the understanding that any sources imported would eventually be repatriated to the country of origin of that sealed source. Under the TOR, radioactive sources would potentially be imported from Argentina, Colombia, Uruguay, and Venezuela. At present, no sources have been imported to Brazil.

The first phase of this project began in September 2007 when personnel from the OSRP and the IAEA traveled to Brazil as part of an IAEA-organized consultancy to condition and package radioactive sealed sources stored in Brazilian storage facilities. Only Brazilian sources were conditioned and packaged. Brazilian and OSRP staff carried out joint conditioning and packaging activities at two Brazilian facilities: the Centro de Desenvolvimento da Tecnologia Nuclear (CDTN), located in Belo Horizonte; and the Instituto de Pesquisas Energeticas e Nucleares (IPEN), located in Sao Paulo.

During the conditioning and packaging operations, the OSRP staff provided IAEA-requested training to CDTN staff in conditioning and packaging procedures. Once the sources were packaged, Brazilian staff consolidated them at an interim storage area located at the IPEN site. The sources were then loaded onto a ship and transported back to the U.S. It should be noted that this ship was also used for repatriating U.S.-origin spent nuclear fuel (low and highly enriched uranium respectively) from Brazil and Argentina as part of another GTRI program. The Brazilian spent nuclear fuel was already stored at IPEN, thus making it ideal to store the packaged sealed sources there as well. Once the sources arrived in the U.S., they were delivered to an interim storage facility pending disposal as DOE material. In all, the GTRI repatriated 127 sealed sources to the U.S., including the first ever repatriation of US-origin Pu-239 sealed

sources which, depending on the country, are prohibited from air-transport due to existing International Air Transport Association regulations.

Figure 3: Disused Devices and Device Disassembly in Brazil

Additional work on this project currently includes pre-missions being conducted jointly by the IAEA and CDTN to assess source inventories in the other partner countries. Based on this data, GTRI will determine which sources are eligible for future repatriation to the U.S. The Latin American Regional Partnership also hopes to develop a disposition pathway for several Indian and Canadian manufactured high-activity irradiators that were identified in the region in 2004.

CHALLENGES IN REPATRIATING SEALED SOURCES

Transportation Challenges:

When considering transportation options for disused plutonium sources, the nature of the source and the appropriate packaging must be identified. Not all plutonium sources outside of the U.S. can be considered special form. The source must either be transported in a Type B package as normal form or encapsulated to meet special form criteria. In order to address this challenge, the OSRP developed a sealed source over-pack to meet special form criteria. The special form capsule can be easily sealed and is fabricated in various sizes to accommodate the full physical size and isotopic range of sealed sources likely to be encountered.

Shipping sealed sources by air is ideal for most recovery operations and can be readily accomplished. However, regulations regarding air shipment of plutonium into and within the U.S. are highly restrictive and are not harmonized with international regulations. Transporting plutonium by air into or within the U.S. can only be legally conducted after qualifying under the following two exemptions: 1) 10 CFR 871.1., National Security reasons; or 2) 10 CFR 871.1.2,

Public Health and Safety reasons. For now, the GTRI program must resort to repatriating plutonium sources by utilizing ocean vessels. Additional challenges to air transportation include rigid package testing requirements and a lack of certified containers. For example, Type AF packages certified for air transport outside the U.S. are not certified for air transport into or within the U. S. without additional testing. While the OSRP continues to pursue certifications for containers, any air shipment of plutonium will still require an exemption under 10 CFR 871.

Denial of Shipment:

Another challenge that impedes the repatriation of sources is the denial of shipment by carriers. Denials of shipment still occur, despite all the mechanisms for ensuring special form, which directly prevents moving at-risk sources from unsecured storage areas to safe and protected locations. For example, carriers maintain authority to choose and reject their cargo and will often refuse to carry radioactive materials. Additionally, carriers will refuse shipment based on the risk of higher costs or they may not have the experience needed to transport Class 7 cargo, especially fissile material. Likewise, countries and individual ports may refuse in-transit shipments or issue severe restrictions and/or fees to control Class 7 cargo. GTRI and OSRP depend upon rapid and effective transportation of radioactive material to ensure the fulfillment of their obligation to return U.S.-origin sources from foreign countries.

Developing pathways for disposition of non-US-origin material:

Currently, GTRI only repatriates U.S.-origin materials either bilaterally or multilaterally from Latin American countries in which they have no disposal pathway or other suitable disposition. However, some radiological sealed sources in Latin America are not of U.S.-origin. One notable example is Canadian-origin teletherapy heads that were manufactured by Atomic Energy of Canada (now MDS Nordion). Devices from other manufacturing countries such as France and India have also been found. Generally, these countries are willing to repatriate their devices, but the associated costs are prohibitive given the small amount of sources that require management.

Given the inherent benefits of radiological sealed sources, such as cancer treatment and oil exploration, and lack of alternatives, ending their use is currently not a viable option. For this reason, source manufacturing nations and the IAEA must continue to work together to solve the problem of how to rapidly, safely and securely dispose of disused sealed sources. The lack of repatriation efforts by major source manufacturing states such as Russia requires the further investigation into proposed concepts such as borehole disposal for shorter-lived isotopes. Based on the inherent security and health risks associated with the loss of regulatory control over sources, a United Nations Resolution or international accord should be drafted outlining the responsibilities of source producers/owners and source manufacturing states for ensuring the prompt disposition of sources once they have outlived their usefulness. However, until disposition problems are resolved, sealed source repatriations are the next best alternative and will continue at little or no cost to other-than-high-income countries that agree to accept the return of sources.

Managing leaking sources:

In one of the efforts previously described, the GTRI/OSRP teams encountered leaking sources that were detected during normal measurements conducted by the radiological control technician, who always accompanies these teams. Some countries in the region may have neither the equipment nor the trained personnel to adequately monitor and prevent unacceptable internal and external doses that may otherwise result from the management of leaking sources. In this case, the IAEA, GTRI, CDTN, and other qualified entities can greatly assist countries by providing suitable monitoring equipment and trained personnel to mitigate leaking sources. The SFC can also be used to re-encapsulate leaking sources once again making them special form. Repatriation and disposal is the only viable long-term solution for leaking sources, especially for those isotopes with very long half-lives.

Management of high-activity sealed sources:

The most challenging problem in the Latin American region is the lack of options for management of high-activity sources and source-containing devices that require Type B containers for movement. As previously noted, Type B containers are very expensive to use – recent shipments have cost hundreds of thousands of dollars for only a small numbers of devices. Alternatives are limited to: 1.- disposing of material in place; 2. removing sources from devices (usually requiring a hot cell) and transporting only the sources; 3. or developing less expensive Type B containers that do not have to be rented and can be purchased at reasonable cost. GTRI has been focused on the latter two alternatives, both supporting IAEA efforts to design and implement a portable hot cell and robust long-term storage shield, and conducting its own efforts to support lower-cost alternative Type B container certification.

Domestically, OSRP has successfully used Department of Transportation (DOT) Specification 6M and 20WC containers for a multitude of disused source recovery operations involving Type B quantities of radioactive sources. This applies when any source exceeds the promulgated A_1 and A_2 values for special form and normal form, respectively. However, DOT Specification packages cannot be used after October 1, 2008, due to a regulatory stipulation and cannot be used for international shipments under the existing US certification. Unfortunately, this includes the 6M and the 20WC. If a disused source meets the definition of special form but exceeds the A_1 value, it can only be transported in a Type B package. Typically, Type B packages are not only expensive to manufacture, license and transport, but are also in short supply, very difficult to operate, require specialized equipment such as cranes, , especially for long shipping times that may be incurred in boat shipments.

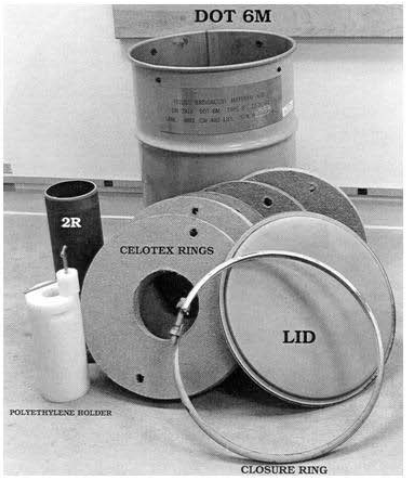

Figure 4: DOT 6M Package & Examples of 20WC Containers

GTRI/OSRP are supporting development of a replacement container for the old 20WC that could be used for similar shipments. The new Type B package will be known as the Model BU-650. Once the design is tested, a Type B Certificate of Conformance (CoC) must be obtained from the U.S. Nuclear Regulatory Commission (NRC). When approved, the OSRP plans to become a registered user and hopefully this will resolve some of the complications of Type B shipments both domestically and internationally.

FUTURE COOPERATION

The GTRI program will continue to pursue sealed source repatriations in Latin America on a bilateral basis, as well as under the IAEA Latin American Regional Partnership. New candidate Latin American countries have been identified and recovery missions are currently being planned. Under the Latin American Regional Partnership, the Brazilian institutions and the IAEA have agreed to play a critical role in this project. CNEN has taken the confidence building measures necessary for further cooperation such as permitting the consolidation of radiological sealed sources at its facilities and agreeing to work with the U.S. Government and the IAEA to repatriate sealed sources and return them to their countries of origin.

The GTRI program has also demonstrated that sealed source repatriations can be coordinated with shipments of spent nuclear fuel. This is especially convenient and necessary when repatriating plutonium sources. Future sealed sources repatriations from the region and abroad will be coordinated with spent nuclear fuel shipments when the opportunity is present, but this is by no means a perfect resolution to the barriers associated with international shipment of radioactive material. Combining repatriation shipments of highly enriched uranium spent nuclear fuel with radioactive sealed sources simultaneously prevents the threat of the proliferation of nuclear weapon useable material and radiological material that could be used for RDDs.

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CONCLUSION

Since May 2004, the GTRI/OSRP has safely recovered 436 sources from foreign countries. Bilateral and multilateral efforts have been successful in removing hundreds of U.S.-origin sealed radioactive sources from Latin American countries in which there is no disposition or long-term disposal pathway. This effort also supports U.S. and international efforts to strengthen life-cycle controls over radioactive sources worldwide, such as the implementation of the non-legally binding IAEA Code of Conduct on the Safety and Security of Radioactive Sources. Improving life-cycle controls, storage, and disposal capabilities through these programs addresses public health and safety concerns, as well as reduces the threat of theft, accidental and deliberate misuse.

Although various challenges remain, the GTRI program will continue to work bilaterally and multilaterally to develop solutions. It is hoped that Latin America will serve as a model for regional cooperation in the repatriation of sealed sources and that the success of GTRI repatriation projects will motivate additional source supplier nations to implement similar programs.

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