Proceedings of the 15th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2007
October 21-26, 2007, Miami, Florida, USA

ISSUES IMPEDING GLOBAL RECOVERY AND TRANSPORTATION OF DISUSED PLUTONIUM SOURCES: LIMITED TRANSPORT OPTIONS AND DENIALS OF SHIPMENT

Justin M. Griffin, PE
Off-Site Source Recovery Project
Los Alamos National Laboratory
Los Alamos, New Mexico, USA

James M. Shuler, DPA
Packaging Certification Program
U.S. Department of Energy
Washington, DC, USA

ABSTRACT

This paper discusses challenges faced by the U.S. Department of Energy's Off-Site Source Recovery Project in its mission to recover U.S.-origin plutonium sealed sources from foreign sites for repatriation to the U.S. Examples of transport options and instances of denials of shipment experienced by the Project are provided. It is insisted that when packages containing plutonium sealed sources are prepared and carried out in accordance with IATA, ICAO, IMO, and/or IAEA[1] Safety Standards, there is no reason for denying the shipment on safety grounds. In addition, if regulations regarding air shipments of plutonium into, and within, the U.S. were harmonized with international regulations the movement of plutonium during recovery operations would be even more simple and efficient. This is most important when retrieving excess, unwanted, or abandoned sources from foreign locations for risk mitigation purposes as directed by the National Nuclear Security Administration. Repatriating disused plutonium sources from countries outside North America is most easily and efficiently accomplished by shipping the packages by air from the source location directly into the U.S. This would decrease transit times (compared to maritime carriage) and improve security by avoiding use of third party countries as the landing point of plutonium air shipments for continued overland shipment of the packages into the U.S. for repatriation, secure storage, and disposition.

INTRODUCTION

The Off-Site Source Recovery Project (OSRP) at Los Alamos National Laboratory (LANL), as part of the National Nuclear Security Administration's (NNSA) Office of Global Threat Reduction, recovers and manages excess and unwanted radioactive sealed sources that present a risk to public health and safety; and sources for which few or no disposal options currently exist.

Sources containing radioactive plutonium, americium, californium, cesium, cobalt, radium, and strontium have been recovered from medical, educational, agricultural, research, industrial, and government facilities. Since 1999, OSRP has been able to recover nearly 16,000 sources from more than 600 sites in 49 States, the D.C. area, Puerto Rico, and a number of foreign countries. This represents recovery of over 172,000 Curies of radioactive material in less than ten years.[2]

[1] Abbreviations: International Air Transport Association (IATA), International Civil Aviation Organization (ICAO), International Maritime Organization (IMO), and/or International Atomic Energy Agency (IAEA).
[2] Totals as of September 15, 2007.

As directed by NNSA, the OSRP mission also includes recovery of U.S.-origin plutonium sealed sources from foreign sites for repatriation to the U.S. The main obstacle to expeditious, efficient, and cost effective repatriation of these plutonium sources is restricted transportation mechanisms available to move fissile material from a place of high vulnerability to a more safe and secure location in the U.S.

ORIGINS AND DISTRIBUTION OF PLUTONIUM SOURCES

There were only four manufacturers of ^{239}Plutonium/Beryllium (Pu/Be) sealed sources in the U.S. which operated at various times from about 1950 to 1973. Manufacturing records were available for each of these sites; and thus the number of actual Pu/Be sealed sources fabricated can be determined. According to records from Los Alamos Scientific Laboratory, Mound Laboratory, Monsanto Research Corp. (MRC), and Nuclear Materials & Equip. Co. (NUMEC), a total of 2,407 Pu/Be sources were fabricated and distributed under the Atomic Energy Commission's loan-lease agreement for research and other peaceful uses of radioactive material.[3]

A careful review of shipping records and sales invoices indicate that 161 Pu/Be sources were originally distributed to users outside the U.S. The loan-lease program ended in 1973, with 160 Pu/Be neutron sources remaining overseas.

Since 2005, OSRP has prepared 15 unwanted Pu/Be sources at foreign locations for repatriation to the U.S.; however, none of these have been successfully returned due to limited transport options or denial of shipment. Additional unwanted Pu/Be sources have been identified outside the U.S. and are marked for OSRP packaging and recovery. An efficient and cost effective method for shipment of Pu/Be sources is needed to allow the OSRP mission to continue.

TRANSPORTATION FOR RISK MITIGATION

It is essential, during each phase of the shipment process, to ensure secure, timely, cost effective, and reliable means to return vulnerable radioactive materials to safe and protected areas. All modes of transport are important to sealed source recovery operations conducted by OSRP. Domestic source recovery routinely involves ground transportation. However, international distribution of U.S.-origin Pu/Be sources depends heavily on air and sea modes of transport for return of at-risk sources to safe and secure areas in the U.S.

Denials of shipment of radioactive material negatively influence the recovery of excess, unwanted, or abandoned sources of radiation for risk mitigation purposes. Impediments to this recovery process lead to increased recovery costs and delays in returning radioactive material to a safe and protected environment. Higher recovery costs and shipping delays counteract the ability of government projects like OSRP (and other organizations) to reduce hazards and threats associated with at-risk sources of radiation quickly and efficiently.

Recent resolutions by IAEA, IMO, and ICAO pave the way for alleviating denial of shipment of sources for medical use. Similarly, transport of recovered sources from at-risk locations to secure environments include a 'humanitarian dimension' where removal is in the best interest of public health and safety; and is conducted for the benefit of society at large.

For example, IMO Resolution A.984(24) encourages facilitation of carriage of compliant Class 7 cargo on maritime vessels because radioactive material has inherent medical and public heath benefits. It is insisted that this view be expanded to the Class 7 cargo being shipped by vessel (and similarly for other modes of transport) for threat reduction and risk mitigation purposes as well. In fact, removal of Class 7 material from an unsecured or at-risk location directly benefits public health by reducing potential risk of accidental exposure and contamination, or intentional misuse in that area. Therefore, no shipments

[3] As provided for by the Atomic Energy Act of 1954.

of Class 7 radioactive material prepared in accordance with established transportation regulations and carried in compliance with maritime or aviation codes should be denied on grounds of safety. Denial of such recovery shipments of at-risk radioactive material is not in the public interest.

TRANSPORTATION CHALLENGES

Special Form Capsule and Packaging Certification

Similar to other Class 7 material, the first step when considering transportation of disused plutonium sources is to identify the nature of the sealed source. The shipper must determine if the source(s) meet the definition of "special form" or not. Based on this analysis, the next step is to identify appropriate packaging.

Each of the 160 Pu/Be sealed sources residing outside the U.S. cannot be considered special form and must either be transported in Type B packaging as normal form; or encapsulated to meet international special form criteria and subsequently transported in a certified Type AF packaging.

To address this first challenge, OSRP has developed field-sealable special form capsules (SFCs) which allow OSRP recovery team members to encapsulate Pu/Be sealed sources into special form. Two of these OSRP special form capsules, known as the Model II[4] and Model III[5], have received IAEA Certificates of Competent Authority which certifies that these SFCs meet the regulatory requirements for special form radioactive material as prescribed in the regulations of the International Atomic Energy Agency (IAEA 2005) and U.S. (DOT 2007) for the transport of radioactive materials.

In addition, OSRP has developed a neutron-shielded packaging configuration for Pu/Be sources. This packaging, known as the Model S300 container, allows for transportation of Model II or Model III SFCs containing Pu/Be sealed sources as a Type A shipment. However, since plutonium is considered fissile material, the container must also be approved for fissile content. To overcome this second challenge, OSRP applied for and obtained a Certificate of Compliance from the U.S. Nuclear Regulatory Commission (NRC) and an IAEA Certificate of Competent Authority for Model S300 Type AF packaging.[6] This certification now allows for safe and legal transport of Pu/Be sources by vessel, rail, or highway with a Criticality Safety Index equal to zero.

Shipment of plutonium by air in the S300 has not yet been approved. Test results of hypothetical accident conditions for air transport are currently under consideration for possible amendment of the Type AF packaging certification to allow air transport in the future.

Denial of Shipment

Despite the fact that OSRP has developed mechanisms for ensuring the special form nature of Pu/Be sources, and for safe and legal transport using certified Type AF packaging, denials of shipment or delays still occur. None of the 15 Pu/Be sources packaged by OSRP internationally have been repatriated to the U.S. due to a lack of cost-effective and efficient transport options for fissile Pu/Be Class 7 material.

The problem of denial of shipment of radioactive material is not a simple one, and is not limited to OSRP experience. Numerous small factors often combine and coalesce to cause denial of some important shipments of radioactive material. Denials of shipment result in delays, additional costs, and in the case of OSRP, directly prevents moving at-risk sources of radiation from relatively unsecured use or storage areas to safe and protected locations.

[4] IAEA Special Form Certificate No. USA/0696/S-96
[5] IAEA Special Form Certificate No. USA/0695/S-96
[6] NRC and IAEA Type AF Packaging Certificate No. USA/9329/AF-96.

NNSA's Office of Global Threat Reduction, through OSRP, depends on successful transportation of radioactive material to recover excess, unwanted, or abandoned sources of radiation within the U.S. and for the return of similar U.S.-origin radioactive sources from foreign locations for risk mitigation purposes. It is essential for this DOE/NNSA program to have a reliable means to return vulnerable radioactive materials to safe and secure environments.

Regulations

Another challenge faced by OSRP and other international transporters of Class 7 material is related to the multiplicity of regulations and regulators which can cause duplicative, overlapping, or even contradictory regulatory oversight.

For example, regulations regarding air shipment of plutonium into, and within, the U.S. are not harmonized with international regulations. Specifically, package testing requirements to meet air transport hypothetical accident conditions in the U.S. require an impact test with velocity of the package being at least 129 meters per second[7] (NRC 2007), whereas corresponding IATA, ICAO, and IAEA regulations require an impact velocity of 90 meters per second[8] (IATA 2005, ICAO 2004, IAEA 2005).[9] This means that Type AF packages certified for air transport outside the U.S. to the 90 meter per second impact velocity, essentially the Type C packaging criteria, are not legal into or within U.S. jurisdiction without additional testing and certification.

Very few packages have been qualified for air transport of plutonium into or within the U.S. One example is the PAT-1[10] packaging developed by Sandia National Laboratory in the 1970s. OSRP personnel are currently investigating the possibility of using PAT-1 packagings for international recovery of Pu/Be sources while concurrently pursuing certification of the Type AF Model S300 container for air transport of plutonium.

EXAMPLES OF SHIPMENT DENIALS

According to an informal survey of the AXS-Alphaliner Top 100 maritime carriers (AXSMarine 2006) conducted by OSRP, most operators avoid carriage of Class 7 cargo while others implement highly restrictive policies. When asked specifically about fissile Class 7 cargo (like Pu/Be sources under UN3333[11]), the container line operator customer service representatives stated that they would not carry such a cargo.

Likewise, countries and individual ports may refuse in-transit shipments or issue severe restrictions or fees to control the Class 7 cargo. Consequently, this leads to an increasing dependence on fewer carriers and transport hubs. These impediments complicate Pu/Be recovery shipments and make them even more difficult and costly.

Examples of denials of shipment of Pu/Be sources encountered by OSRP include:

Refusals by Carriers – Since carriers maintain the rights to choose which cargo they transport, some denials of shipment are simple business decisions. Certain costs are associated with training employees, maintaining regulatory compliance, insurance, record-keeping, possible adverse publicity, etc. Carriers

[7] Approximately 423 feet per second or 289 miles per hour.

[8] Approximately 295 feet per second or 201 miles per hour.

[9] More specifically, IATA Dangerous Goods Regulations, Paragraph 10.6.3.7.4; ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air, Paragraph 7.19.4; and IAEA Regulations for the Safe Transport of Radioactive Material, TS-R-1, Paragraph 737.

[10] NRC Type B Fissile Packaging Certificate No. USA/0361/B(U)F-96.

[11] The proper shipping name associated with ID No. UN3333 is "Radioactive Material, Type A Package, Special Form, Fissile."

are not always willing to subject themselves to the additional cost and scrutiny of transporting Class 7 cargo, especially fissile material.

Where shipments of radioactive material are prepared and carried out in accordance with established international transport regulations, there is no reason for carriers to refuse the shipment on safety grounds. However, carriers often choose to refuse the shipment because they are not willing to make the "commercial decision" to transport such material.

Other carriers are willing to transport only certain types of radioactive cargo. When less common shipments of radioactive material, such as fissile Pu/Be sources, are requested, carriers may refuse to handle the shipment simply because they have little experience transporting fissile radioactive material.

Denial of Entry or Transshipment of Radioactive Material – Countries that prohibit Class 7 cargo into any of its ports or airports, whether for entry or while "in-transit," also impede recovery of excess, unwanted, or abandoned Pu/Be sources for risk mitigation purposes.

Use of Cargo Aircraft Only – U.S. regulatory restrictions, as well as those of other countries, of most non-medical isotope shipments to cargo only aircraft is a complicating factor which hinders rapid transfer of recovered radioactive sources to the U.S. This exclusion severely limits the ability of OSRP to return U.S.-origin Pu/Be sources from overseas locations to safe and secure areas in the U.S. in a timely manner.

Shipping Radioactive Material by Air – U.S. transportation regulations prohibit all but the smallest quantities of plutonium on airfreight shipments, even though safe and secure shipments are possible by air. The basis for this rule rests with congressional desire to prevent over-flights of the U.S. by very large quantities of plutonium in shipments of reprocessed nuclear fuel, but also hampers shipment of Pu/Be sources for risk mitigation purposes.

If restrictions change to allow air shipments of Pu/Be sources into major freight airports and if package testing requirements for fissile material in the U.S. are harmonized with international regulations, the movement of plutonium during recovery operations would be even more simple and efficient, while safety is maintained to a high standard.

Shipment of Pu/Be sources by air is most important when retrieving excess, unwanted, or abandoned sources from foreign locations for risk mitigation purposes. Returning recovered plutonium from overseas is most easily and efficiently accomplished by sending it by air from the source location directly to the U.S. This is inherently more secure than other modes of transport, decreases transit time (compared to maritime shipment), and would avoid the use of third party countries as hosts for the landing of these shipments.

IMPLICATIONS WITH RESPECT TO SEALED SOURCE RECOVERY

Higher recovery costs and shipping delays, caused by denials of shipment of radioactive material, counteract the ability of governments and organizations to efficiently reduce hazards and threats associated with at-risk sources of radiation quickly and efficiently. Without efficient and cost effective means to recover and return vulnerable radioactive material such as unused Pu/Be sources to safe and secure environments, the global threat of accidental exposure to members of the public or intentional misuse by criminal factions remains high.

Recovery of at-risk sources is a high profile project and has received attention, nationally, regionally and internationally. Teams and organizations performing recovery activities can do good work; however, when denials of shipments occur, actual benefits of the recovery operation cannot be realized.

CONCLUSIONS

The world depends on a global system of transport. Therefore, it is necessary for all organizations involved in the shipment of Class 7 cargo to be involved in resolving these and other issues related to denials of shipment of radioactive material. Transport of recovered sources from at-risk locations to secure environments include a 'humanitarian dimension' where recovery is in the best interest of public health and safety; and is conducted for the benefit of society at large.

Ensuring efficient and cost effective means of domestic and international shipment of excess, unwanted, or abandoned sources of radiation for risk mitigation purposes is vital to global threat reduction and the health and safety of people around the world.

Viable shipping options are very important when retrieving excess, unwanted, or abandoned Pu/Be sources from foreign locations for risk mitigation purposes as directed by NNSA. Repatriating disused plutonium sources from countries outside North America would be most easily and efficiently accomplished by shipping the packages by air from the source location directly into the U.S. This would decrease transit times (compared to maritime carriage) and improve security by avoiding use of third party countries as the landing point of plutonium air shipments for continued overland shipment of the packages into the U.S. for repatriation, secure storage, and disposition.

ACKNOWLEDGMENTS

This work was funded through NNSA's Office of Global Threat Reduction (NA-21) and the U.S. Department of Energy's Office of Environmental Management (EM-60). The authors wish to thank and acknowledge members of OSRP at Los Alamos National Laboratory, and Marvin Bennett of Eagle Research Group, Inc. for their support and technical assistance. Los Alamos National Laboratory is operated by the Los Alamos National Security, LLC for NNSA under contract DE-AC52-06NA25396.

REFERENCES

AXSMarine. AXS-Alphaliner Ranks the Top 100 Liner Operators. http://www.axsmarine.com/public/top100/index.php (Accessed 06 May 2006).

International Air Transport Association (IATA). Dangerous Goods Regulations. Montreal: IATA; 46th Edition; Paragraph 10.6.3.7.4; 2005.

International Atomic Energy Agency (IAEA). Regulations for Safe Transport of Radioactive Material. Vienna: IAEA; Safety Standards Series No. TS-R-1; 2005.

International Civil Aviation Organization (ICAO). Technical Instructions for the Safe Transport of Dangerous Goods by Air. Montreal: ICAO; 2005-2006 Edition; Paragraph 7.19.4; 2004.

International Maritime Organization (IMO). Resolution A.984(24). "Facilitation of the Carriage of IMDG Code Class 7 Radioactive Materials Including Those in Packaged Form used in Medical or Public Health Applications"; 2006.

U.S. Department of Transportation (DOT). Washington, DC: U.S. Government Printing Office; 49 CFR Parts 100-199; 2007.

U.S. Nuclear Regulatory Commission (NRC). Packaging and Transportation of Radioactive Material. Washington, DC: U.S. Government Printing Office; 10 CFR Part 71; Section 74; 2007.