# Disposal Process for High Activity Sources by a University through the U.S. Dept. of Energy's Off-Site Source Recovery Project - 12076

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## ABSTRACT

Sealed radioactive sources are used in a wide variety of applications by a large number of license holders in the Unites States. Applications range from low-activity calibration sources to high-activity irradiators for engineering, research, or medical purposes. This paper describes and evaluates the safety and security measures in place for disused sealed sources, in particular of high activity sealed sources at the end of their operational life-time. The technical, radiation protection, and financial challenges for licensees and the Competent Authorities are reviewed from the point of view of the license holder. As an example, the waste management processes and the chain of custody for disused research irradiator sources are followed from extraction from the irradiator facility to the source disposal or recycling contractor. Possible safety and security concern in the waste disposal process are investigated in order to identify improvement potential for radiation protection or source security.

Two shipments of disused sealed sources from Colorado State University (CSU) have been conducted through the CSU Radiation Control Office (RCO) in the last two years, with a third shipment expected to be completed by the end of November 2011. Two of the sources shipped are considered 'high' activity and exceed the U.S. NRC limits requiring increased controls for security purposes. Three sources were shipped in 2009 and ten more are expected in 2011. A total activity of 117.3 GBq was shipped in 2009. Nine sources were recently shipped in October 2011 through a third party waste broker where the total activity was 96.34 GBq. The last source is scheduled for shipment no later than 30 November 2011 and contains an activity of 399.96 GBq.

## INTRODUCTION

For the past four years, CSU has been actively pursuing a means of disposal for several historic sealed sources no longer being used by the University. Shipments of these sources were coordinated through multiple federal and state entities but ultimately through the Los Alamos National Laboratory (LANL) Off-Site Source Recovery Project (OSRP).

Security considerations have been at the forefront of all duties pertaining to high activity sealed sources since the events of September 11, 2001. The increased threat of potential terrorist activity utilizing high-level sealed radiation sources prompted federal regulators to increase security requirements on all U.S. licensees. Federal guidelines requiring increased controls on high activity sources and irradiators became part of CSU's license in 2005. Through a state inspection in 2007, CSU learned of the OSRP and initiated a process with multiple federal contacts and agencies to schedule disposal of sources no longer being utilized by the University.

The University's license requires that high activity sources have a disposal plan. However, some historic sources predated these requirements, such that appropriate budgetary reserves had not been established. They contained high activities for which disposal costs would have exceeded reasonable budgetary means. For instance, the cost for disposal of one high activity source was previously quoted to be in excess of $100k. The OSRP made possible disposal of high activity sources where budgetary constraints previously relegated these sources to permanent storage.

## MATERIALS AND METHODS

### OSRP

The OSRP was established in 1998 at LANL to address orphaned or disused radioactive sources, a responsibility of the U.S. Department of Energy (DOE). The program allows for transportation, storage, and final disposal of sources when a means can be created [1]. Due to the events of September 11, 2001, the responsibility of the OSRP was shifted to the National Nuclear Security Administration (NNSA) as a result of an evaluation of terrorist threats involving NRC licensed nuclear facilities. At that time, the OSRP was expanded to include recovery of sources that could present a credible security risk to the United States [2].

### Rocky Mountain Low Level Radioactive Waste Board

Any shipment of radioactive waste from CSU must be approved and recorded with The Rocky Mountain Low Level Radioactive Waste Board (RMLLWB). The RMLLWB is an interstate government agency that administers The Rocky Mountain Low-Level Waste Compact. The Compact was created by legislation passed by the member states of Colorado, Nevada, and New Mexico [3], following legislation in The Low-Level Radioactive Waste Policy Act [4]. The states of Arizona, Utah, and Wyoming have not ratified the Compact. It is an independent regulatory organization that is not an agency of any of its member states. The Compact received Congressional approval via the Omnibus Low-Level Radioactive Waste Interstate Compact Consent Act, P.L. 99-240. Thus, the Compact is authorized by both federal and state law. The main purposes of the Compact are to provide for the disposal of low-level radioactive waste (LLW) produced within the member states and to regulate the interstate commerce aspects of LLW. The Board was established in 1983. The Board consists of one member appointed by the governor of each member state [3]. CSU must report a volume for each shipment to the RMLLWB and request an export permit to a disposal site. The export permit request must specify the activity being shipped, classification of waste, grams of nuclear material, grams of transuranic waste, the volume and final destination of the waste. A shipper must comply with the date limits set for shipment and final disposal or pay additional fees for amendments to the export permit.

## RESULTS AND DISCUSSION

### Timeline and contacts

CSU discussed disposal of high activity and unused radiation sources in 2007 with an inspector from the Colorado Department of Public Health and Environment (CDPHE). The state inspector had learned of the OSRP program through the Conference of Radiation Control Program Directors (CRCPD) and in particular, their Source Collection and Threat Reduction Program (SCATR). The SCATR program is limited to sources that do not meet International Atomic

Energy Agency's (IAEA) Category 1 and 2 sources [5]. Examples of sources that would be eligible for the SCATR program include medical brachytherapy sources (Cs-137 and Ra-226), eye applicators, low activity sources that exceed the NRC 120-day half-life limit for decay-in-storage, long half-life industrial sources, and calibration sources [6]. From that discussion, CSU registered sources through CRCPD's SCATR website using a Microsoft Excel™ template. In 2008, a visit from the DOE's Global Threat Reduction Initiative (GTRI) group prompted expedited discussions about the sources CSU had registered with SCATR. LANL was contacted directly, and the process was initiated. A team from LANL arrived in late 2009 to transfer the sources to a Type A container for shipment. In 2010, the first sources were shipped to Nuclear Sources and Services, Inc. (NSSI). Phase two of CSU's disposal process for the remaining sources began in April 2010. CSU's second shipment occurred on 11 October 2011 and the third shipment is scheduled to be no later than March 2012. A complete timeline of events in the disposal process is provided in Table I.

Table I. Timeline of Correspondence and Processes for Final Disposal

| Date | Action |
|---|---|
| Oct. 2007 | Sources registered with the SCATR Program via Excel spreadsheet from website |
| Aug. 2008 | DOE visit through GTRI facilitates contact with LANL establishes working base |
| Jan. 2009 | LANL contacts CSU to update their database |
| Sep. 2009 | LANL contacts CSU to initiate disposal of the actinides |
| Oct. 2009 | CDPHE grants permission for CSU to remove the sources from their original housings |
| Dec. 2009 | Scheduled date with LANL to package sources |
| Jan. 2010 | Type 7A 55 Gallon paraffin drum delivered to CSU for transport of the sources |
| Jan. 2010 | LANL team packages sources |
| Feb. 2010 | CSU ships drum to NSSI |
| Apr. 2010 | CRCPD contacts CSU to begin Phase II of disposal. |
| Sep. 2010 | CDPHE contacts CRCPD to inquire on the program's status |
| Feb. 2010 | CRCPD contacts CSU to renew disposal efforts |
| Mar. 2011 | Diagrams / schematics sent to CRCPD for 3rd party transportation brokers bidding process |
| Mar. 2011 | Project out to bid for 3rd party brokers |
| May 2011 | Quote received from CRCPD |
| May 2011 | CSU offers to cover some costs to assist CRCPD's extended budget |
| Oct. 2011 | Sources packaged and shipped by 3rd party broker |

**Phase I source collection**

Three sources were identified as candidates for the OSRP, all of them containing Am-241. However, CSU was only able to remove two sources, as there was not enough documentation on hand to satisfy the OSRP requirements. Both sources removed were mixed with Beryllium making the mixed source a generator of neutron radiation. Once source in particular presented a challenge for removal as it was encased in the housing of an old Nuclear Chicago density gauge, Model 1418 (35 mCi – 1970). Permission to remove the source for the OSRP was granted by the CDPHE after an extensive safety plan was presented to ensure safe removal of the source. Removal was completed in stages whereby wipe tests and surveys were conducted by CSU to verify the source was not compromised. Lead shields, long necked screw drivers and a twenty-four inch "grabber" were used to maximize distance and keep doses ALARA. This source was transferred to a paraffin drum for temporary storage prior to final packaging with the LANL OSRP team. U.S. DOE shipped the sources to NSSI in Houston, TX, using a shielded 55 gallon drum, Type A package. An Authorization to Transfer/Relinquishment of Ownership/Custody was agreed upon and signed off by LANL and CSU. After shipment to

NSSI in Houston, the sources were transferred to DOE ownership and are stored under DOE license exemption. Details on the three sources shipped during Phase I of the source disposal are provided in Table II.

Table II. Actinide Sources Shipped to NSSI in 2009

| Isotope | Activity (GBq) | Assay Date | Manufacturer | Serial No. | Model |
|---|---|---|---|---|---|
| Am-241:Be | 108.6 | Unknown | NUMEC | 93AM137 | AM-93 |
| Am-241:Be | 1.3 | 2/12/1970 | Nuclear Chicago | 81 | 1418 |

**Phase II source collection**

Sources identified for Phase II were closer to the SCATR program definition. CSU stored these sources in either their original housings or shields that had traditionally held the sources for some time. U.S. DOE placed CSU's Phase II source collection and transportation out for 3rd party bid. A transportation broker was identified and worked with CSU to arrange for disposal of the sources. An export permit was obtained from the RMLLWB prior to shipment. Since these sources were already shielded, an ALARA decision was made to custom build a Type 7A package that could house all of the sources within their shields at one time. Transfer of the sources to the 7A package required a fork-lift utilized by CSU's Facilities Management Department. One source in particular weighed in excess of 3k lbs. All sources were able to fit within the custom Type 7A container. It is our understanding that the timeframe to complete the construction of the container was three months. This single Type 7A package was then transported via the contracted waste broker to NSSI in Houston. The sources shipped to NSSI in Phase II of the CSU disposal effort are summarized in Table III.


Fig. 1. Loading of the sources into a custom Type 7A container.

Final disposal will be at the Commercial Low-Level Radioactive Waste Disposal Site in Richland, Washington (AKA Benton County). Benton County was selected as it is permitted to accept sealed sources where Envirocare in Utah is not permitted to do so. Disposal at Benton County required that CSU apply for a site use permit through the State of Washington and pay a fee for the application. CRCPD requested that CSU provide additional funds towards the final disposal costs, as there was insufficient funding in the federal program to handle all of the requests for disposal the program was receiving nationwide. CSU provided a summary of their

budgetary constraints, after further negotiation with CRCPD, contributed ~ $21k for the Phase II shipment and disposal. Preparations for the final source shipment are currently underway. At this time, it is unknown how the broker will ship the final source.

Table III. Sources Shipped to NSSI in 2011

| Isotope | Activity (GBq) | Category | Assay Date | Manufacturer | Serial No. | Model |
|---|---|---|---|---|---|---|
| Cs-137 | 0.77 | 5 | 1996 | Radiochemical | B02503 | Unknown |
| Co-60 | 84.36 | 3 | 1996 | Picker X-Ray Corp | 81 | P3802A |
| Co-60 | 3.31 | 4 | 1966 | 3M | Unknown | Unknown |
| Cs-137 | 2.99 | 4 | 1974 | Unknown | Unknown | Unknown |
| Cs-137 | 0.64 | 5 | 1981 | Isotope Products | F057 | HEG-137-30 |
| Co-60 | 0.514 | 4 | 1970 | Unknown | Unknown | Unknown |
| Cs-137 | 0.149 | 5 | 1972 | Unknown | Unknown | Unknown |
| Cs-137 | 2.58 | 4 | 1972 | Unknown | Unknown | Unknown |
| Sr-90 | 1.03 | 5 | 1960 | Tracer Lab | 708 | RA-1 |

**Security during transport**

Security for all shipments follows US Department of Transportation (DOT) regulations, in particular 10 CFR 20.1801 and 1802 [7]. In 2005, the NRC amended these rules to include quantities of concern for particular isotopes, increasing security requirements for facilities, including during shipping of sources. Those quantities of concern and increased controls have been added specifically to all licenses (including CSU's) in the US and reflect similar considerations at the international level by the IAEA [8].

For shipping, security is dependent on whether or not the shipment exceeds the quantity of concern. For multiple sources, an algebraic formula using the individual isotope-specific values determines the total quantity of concern for that specific shipment. A shipping company is required to develop a security plan that includes such measures as the drivers checking in with their home base every day, notifying home base from any divergence from the planned route, etc.

If a shipment is below the quantity of concern, the driver is responsible for security and has to remain with the vehicle at all times, including sleeping in the truck's cab. Drivers are asked to avoid patterns for stops and over-night stays during extended shipments. They are not required to stop in a secured truck stop area. For restroom breaks, they will call ahead and make the truck stop aware of the shipment so it can be monitored while they are away from the truck.

If a shipment is above the quantity of concern, drivers are required to follow a Highway Route Controlled designation for the shipment. This is defined in the relevant USDOT regulations as approved routes where hazardous materials are permitted to travel. The driver is responsible for security and stays with the shipment at all times. Preference is given to routes which can be completed within a day. Any stop for an extended stay needs to be in a secured truck stop. That shipment is required to have a specific security plan which includes "safe haven locations". Those truck stops provide video surveillance for the trailers.

## CONCLUSIONS

Radiation waste disposal of high activity sources in large shields with unknown manufacturers, serial numbers, or model numbers is an arduous process requiring multiple contacts with various state and federal agencies. DOE's OSRP has made it possible for CSU to dispose of older unused sources in an economically viable way. Disposal of multiple sources all at once was not an option prior to the establishment of the SCATR program. While CSU was able to dispose of sealed sources when funds were available, the cost to the University would have been prohibitive for this type of mass removal and disposal of radiation sources initiated within this initiative. Where we estimate a cost of about $130k to ship these sources otherwise, CSU's contribution of $21k realized ~ a significant savings in what would have been an impossible disposal cost. Removing unused radiation sources from CSU has realized a cost savings while removing a potential security threat.

## REFERENCES

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