

LA-UR-

11-03533

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*Title:* Recent Challenges and Accomplishments in Characterizing Sealed Sources for Disposition to the Waste Isolation Pilot Plant

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*Intended for:* Health Physics Society  
Conference, June 2011



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## **Recent Challenges and Accomplishments in Characterizing Sealed Sources for Disposition to the Waste Isolation Pilot Plant**

By Ioana Witkowski, Alex Feldman, Mike Pearson

For the past ten years, the Offsite Source Recovery Project (OSRP) has been recovering excess and unwanted radioactive sealed sources that pose a potential risk to public health and safety. The OSRP is part of the National Nuclear Security Administration's Global Threat Reduction Initiative (GTRI) and has been able to recover over 25,000 sources from more than 900 US and international sites. The project's original mission included recovering sources, packaging them in shielded containers, and providing interim storage pending approval for disposal at the Waste Isolation Pilot Plant (WIPP). The GTRI/OSRP mission has since expanded and evolved from recovering  $^{239}\text{Pu}$ ,  $^{238}\text{Pu}$  and  $^{241}\text{Am}$  sources to include high activity  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$ , and  $^{90}\text{Sr}$  sources. OSRP continues to search for new disposal avenues for other radioisotopes, such as  $^{237}\text{Np}$ ,  $^{244}\text{Cm}$ , and  $^{252}\text{Cf}$ . This paper focuses on the details of the WIPP compliant characterization process for disposal of transuranic (TRU) sealed sources. This process provides an isotopic distribution and activity analysis for all ten WIPP tracked radioisotopes. To meet characterization requirements, each source is characterized using acceptable knowledge "AK" of the available radiological information, in lieu of non-destructive assay testing. Challenges include: identifying source data, such as activity and date of manufacture; obtaining historical process documentation from source manufacturers; correcting for the presence of multiple isotopes; and disposing of radioactive materials that contain a mixture of TRU radionuclides with target elements, such as Lithium. We are now developing characterization methodologies for  $^{244}\text{Cm}$  and  $^{252}\text{Cf}$ , which have half-lives less than 20 years, but contain long lived impurities and in-growth daughters. We discuss the challenges in disposition of all of these isotopes at WIPP and discuss our approach to meet characterization requirements.

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# *Recent Challenges and Accomplishments in Characterizing Sealed Sources for Disposition to the Waste Isolation Pilot Plant*

**Health Physics Conference June 2011**

*by Ioana Witkowski, Alex Feldman, Mike Pearson*



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## Off-Site Source Recovery Project (OSRP)

- **OSRP's Mission – Eliminate excess, unwanted, abandoned, or orphan radioactive sealed sources that pose a potential risk to public health, national security, and safety.**
- **OSRP is part of the National Nuclear Security Administration (NNSA) Office of Global Threat Reduction.**
- **OSRP addresses radiological threat reduction for NNSA by aggressively removing radioactive materials (in the form of sealed sources) from the public sector that could pose a terrorist threat if acquired.**

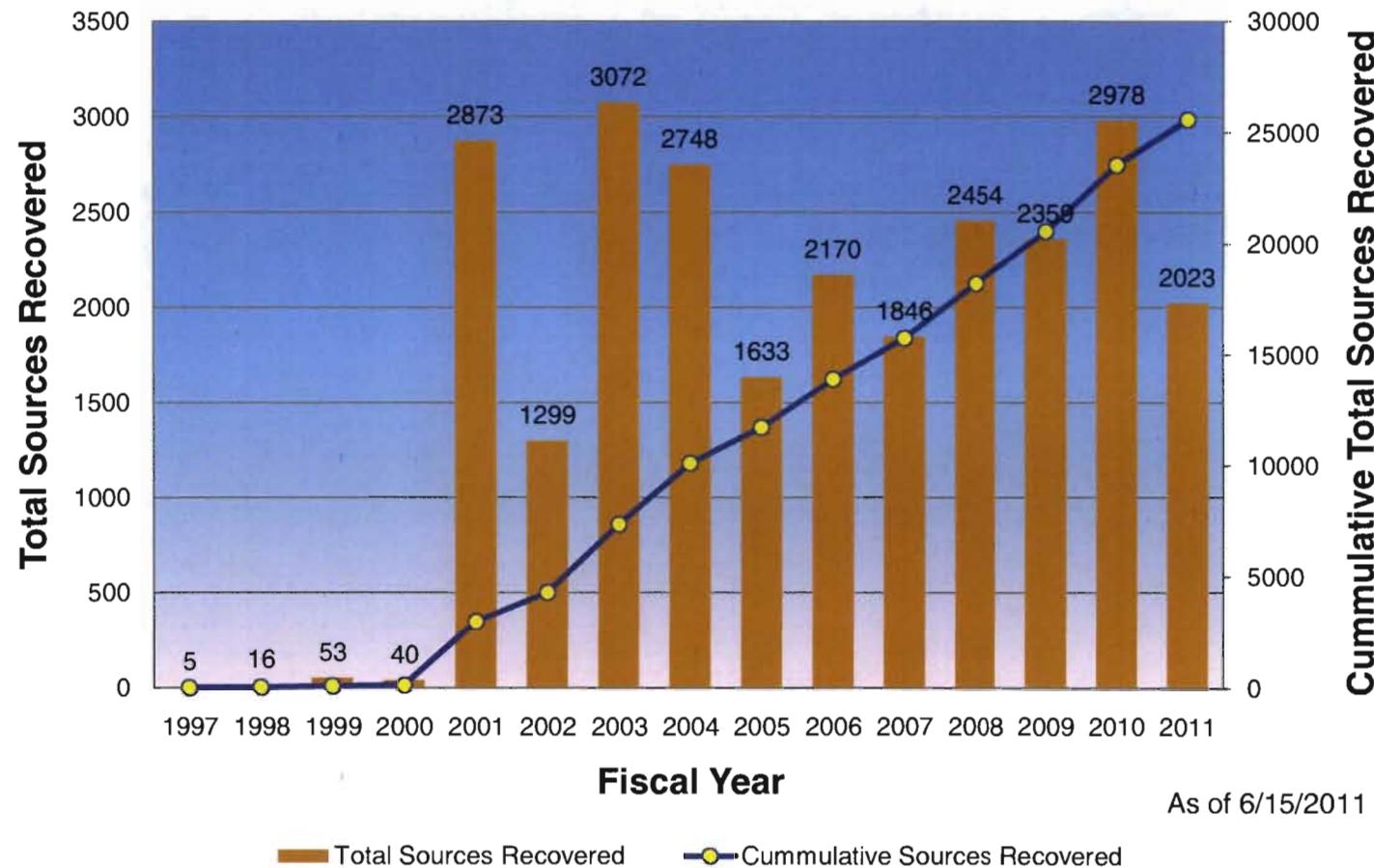


## Project Accomplishments

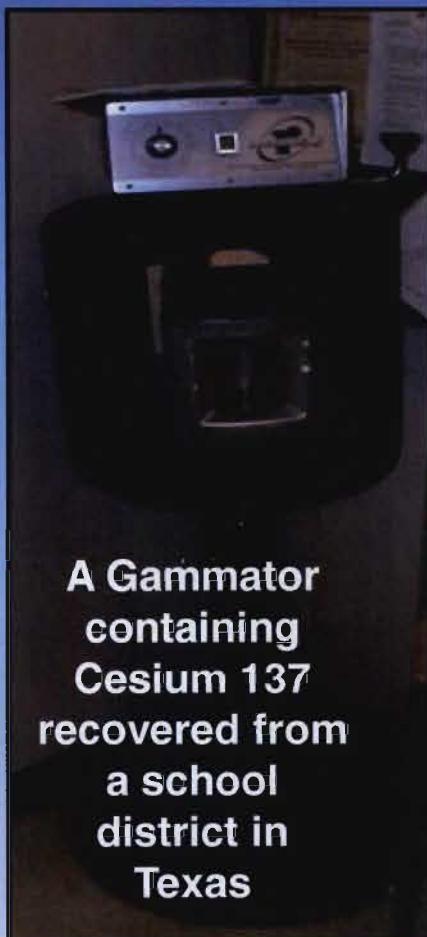
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- Project started in 1999 at LANL and since OSRP recovered over:
  - 25,000 sources present in US at more than 900 sites
  - 1000 sources internationally
- A DOE/NNSA Defense Determination in 2003, allowed OSRP to begin final disposition of all  $^{239}\text{Pu}$  sources at WIPP. Similar Defense Determinations were obtained in 2006 for  $^{238}\text{Pu}$  and  $^{241}\text{Am}$ .
- First NTS disposal of  $^{60}\text{Co}$  occurred in 2008.
- OSRP's mission expanded in training international community in source management, support to and joint missions with IAEA, and in GTRI tasks related to Search and Secure

# Total Sources Recovered by OSRP per Fiscal Year



# Isotopes Managed



## Nuclides Originally Managed

$^{241}\text{Am}$

$^{239}\text{Pu}$

$^{238}\text{Pu}$

$^{252}\text{Cf}$

## Additional Nuclides Currently Managed

$^{244}\text{Cm}$

$^{226}\text{Ra}$

$^{90}\text{Sr}$

$^{60}\text{Co}$

$^{137}\text{Cs}$

$^{192}\text{Ir}$

**All nuclides currently found in  
IAEA sealed sources of  
concern list**

# Who Uses Radioactive Sealed Sources?



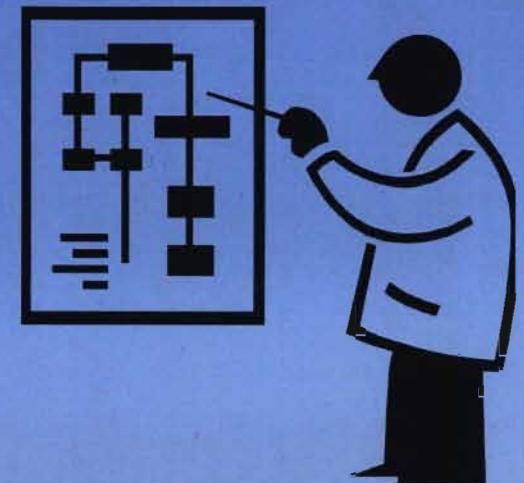
**50+ Years of Isotope Distribution in the U.S.**

- Oil and Gas Service Companies
- Colleges and Universities
  - Manufacturing
  - Medical Facilities
  - Military Installations
  - Construction Industry
  - DOE and Government Sites

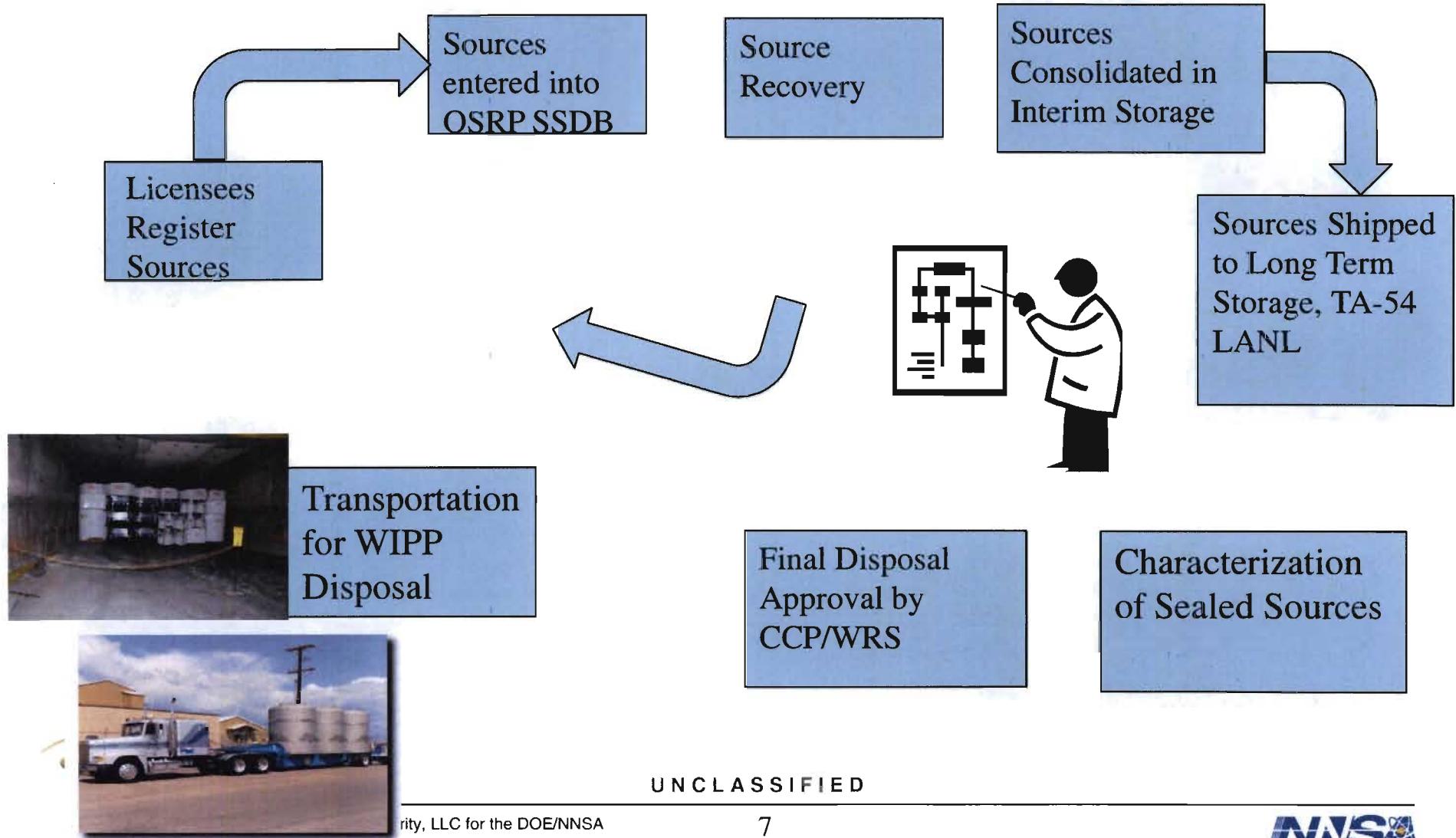


# OSRP Operation Processing Steps

1. Licensees Register Sources
2. Sources Entered into OSRP Database
3. OSRP Organizes Source Recovery or Self-Ships
4. Sources Consolidated in Interim Storage
5. Sources Shipped to Long-Term Storage
6. Characterization of Sealed Sources for WIPP
7. Final Disposal Approval by CCP/WRS
8. Transportation for Disposal to WIPP



# OSRP Operation Process Flow Diagram



## Characterization of Transuranic Sealed Sources

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- Acceptable Knowledge in lieu of NDA information required: **isotope**, **activity**, **date of manufacture**.
- Characterization software decays the isotopes for all existing sources in a drum providing a report for the ten WIPP tracked isotopes ( $^{241}\text{Am}$ ,  $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ ,  $^{242}\text{Pu}$ ,  $^{233}\text{U}$ ,  $^{234}\text{U}$ ,  $^{238}\text{U}$ ,  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$ ).
- Calculations ensure the sources meet the transuranic waste WIPP criteria and provide input for TRUPACT II transportation.

# Input to the OSR Characterization Database Software version 1.0

Source Characterization

Please enter your name: Ioana Wikowski

Pick a Container LA#: 64585

Run Date: 6/30/2011

Notes:

Weight of SFC's (including sources): 4000

Weight of Sources NOT in SFC's: 0

Total: 4000

Grams	Curies	Weight	Mfr Date	Serial Num	Isotope	Manufacturer	Shape	D	Length
	3		3/3/1965	930AM137	241Am/Be	Numec	cylindrical	0.8	1.98
	0.035		2/12/1970	AM310	241Am/Be	Monsanto Research Corporation			

Record: 14 2 of 2



# Isotope Distributions and Uncertainties Associated with Activity Calculations

Edit Lists

Characterization Nuclides Isotopes Containers Source Manufacturers SFC's SFC Types

Isotope 241Am

Source Characterization Nuclides (must have RadDecay names to appear). All the nuclides you want to appear on reports should be listed here. If anything is not applicable, or if its value is zero, just leave it out.

Nuclide	Is Alpha Emitter?	% Error	Mean Ci/G of Material	Curie Fraction
241Am	<input checked="" type="checkbox"/>	1.43%	3.47E+00	1.00E+00
238Pu	<input checked="" type="checkbox"/>	55.61%	3.56E-05	1.03E-05
239Pu	<input checked="" type="checkbox"/>	54.41%	1.74E-04	5.01E-05
137Cs	<input type="checkbox"/>	97.99%	6.87E-08	1.98E-08
90Sr	<input type="checkbox"/>	97.99%	6.18E-08	1.78E-08
240Pu	<input checked="" type="checkbox"/>	54.47%	1.28E-04	3.69E-05
241Pu	<input type="checkbox"/>	54.42%	4.14E-03	1.19E-03
233U	<input type="checkbox"/>	1.43%		
234U	<input type="checkbox"/>	55.61%	7.26E-14	2.09E-14
238U	<input type="checkbox"/>	74.81%	1.95E-13	5.61E-14
242Pu	<input checked="" type="checkbox"/>	55.61%	4.75E-08	1.37E-08
236Pu	<input type="checkbox"/>			
235U	<input type="checkbox"/>	54.41%	3.14E-15	9.06E-16

Record: 14 1 of 13 < > No Filter Search

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# Output from the OSR Characterization Database Software

NDA / Radiological Characterization BDR#			LA11-OSR-CH-006						
Container:	LA00000064585	Waste Weight (kg)	4.000						
Run Date:	6/30/2011								
<b>Decay Corrected Data</b>									
Nuclide	Mass (grams)	Mass 1.00 Sigma Error (grams)	Activity (Ci)	Activity 1.00 Sigma Error (Ci)	FGE	PE-Ci	Decay Heat (W)	% Type A Limit	TRU Alpha Activity (Ci)
Cs-137	2.36E-10	2.28E-10	2.08E-08	2.01E-08	0.00E+00	0.00E+00	2.30E-11	3.84E-10	0.00E+00
U-233	4.56E-07	6.46E-09	4.45E-09	6.30E-11	4.10E-07	1.39E-09	1.29E-10	4.05E-12	0.00E+00
U-234	5.43E-07	2.99E-07	3.43E-09	1.89E-09	0.00E+00	0.00E+00	9.89E-11	3.12E-12	0.00E+00
U-235	3.16E-06	1.70E-06	6.93E-12	3.73E-12	2.03E-06	0.00E+00	1.91E-13	0.00E+00	0.00E+00
Pu-238	1.25E-06	6.89E-07	2.17E-05	1.19E-05	1.42E-07	1.97E-05	7.18E-07	8.03E-08	2.17E-05
U-238	5.02E-07	3.71E-07	1.71E-13	1.26E-13	0.00E+00	0.00E+00	4.32E-15	0.00E+00	0.00E+00
Pu-239	2.41E-03	1.30E-03	1.52E-04	8.17E-05	2.41E-03	1.52E-04	4.71E-06	5.62E-07	1.52E-04
Pu-240	4.85E-04	2.61E-04	1.11E-04	6.00E-05	1.09E-05	1.11E-04	3.47E-06	4.13E-07	1.11E-04
Am-241	8.12E-01	1.15E-02	2.82E+00	3.98E-02	1.52E-02	2.82E+00	9.42E-02	1.04E-02	2.82E+00
Pu-241	3.75E-06	2.01E-06	3.90E-04	2.09E-04	8.43E-06	7.64E-06	1.24E-08	3.54E-07	0.00E+00
Pu-242	1.05E-05	5.76E-06	4.16E-08	2.29E-08	7.85E-08	3.78E-08	1.23E-09	1.54E-10	4.16E-08
Sr-90 Other Isotopes	1.28E-10	1.23E-10	1.76E-08	1.70E-08	0.00E+00	0.00E+00	2.04E-11	2.17E-09	0.00E+00
Total*	8.15E-01	1.16E-02	2.82E+00	3.98E-02	1.76E-02	2.82E+00	9.42E-02	1.04E-02	2.82E+00
*RMS for errors									
(1.00 Sigma Error)									
Tru Alpha Activity Concentration	7.05E+05			9.96E+03			nCi/g		
Tru Alpha Activity	2.82E+00			3.98E-02			Ci		
Total Pu-239 Equiv Activity	2.82E+00			3.98E-02			Ci		
Total Pu-239 Fissile Gram Equiv	1.76E-02			1.32E-03			g		
Total Decay Heat	9.42E-02			1.33E-03			W		
	Printed Name				Signature				Date
RC Operator Review									
2nd RC Operator Review									

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## Identification: Source/Device Information

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- Acceptable Source Information for radiological characterization
  - Source certificate
  - Source markings
  - Source listed in DOE-NMMSS database
  - Shipping records
  - Fabrication documents
  - Source manufacturer
  - Model type or number/serial number
  - Sales catalogue
  - Physical shape and dimensions
  - NRC Sealed Source Device Registry

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## Identification: Source Self-Identification



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## Challenges Encountered

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- Poor management of source information at the licensee sites
- Most commercial source manufacturers went out of business - lack of historical process documentation and source information
- Source information collected before WIPP requirements were defined - does not satisfy all of the current stringent criteria for disposal
- Sources in interim storage for long time - loss of valuable information with time
- Older sources become non-special form with time before recovery - non-compliance with WIPP requirements, special form packaging considerations

## Challenges Encountered (cont'd)

- Recovering sources containing new isotopes  $^{244}\text{Cm}$  and  $^{252}\text{Cf}$  and qualifying them for WIPP disposal:
  - $^{244}\text{Cm}$  based on in-growth of  $^{240}\text{Pu}$  and impurities in original material
  - $^{252}\text{Cf}$  based on impurities in original material and some in-growth of TRU isotopes.
- Adding  $^{237}\text{Np}$  sources to the list of WIPP disposable sources

## Accomplishments

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- Accommodating new characterization methods for combination sources - neutron/gamma sources  $^{241}\text{AmBe}/^{137}\text{Cs}$  used in moisture/density probes.
- Qualifying for disposal non-hazardous neutron type sources containing a mixture of radioisotope with a light element such as Li.
- Disposal of sealed sources containing RCRA metals such as Cd, based on approval of LANL permit by NMED, opening new avenues for more diverse source recoveries.
- During FY10 the inventory of our TRU drums in storage at LANL was decreased by 50% by characterizing for WIPP disposal about 300 drums.
- OSRP developed and maintains a unique set of comprehensive databases in the US with information about sealed source.

# DO YOU HAVE UNWANTED SOURCES?

**Register them at [osrp.lanl.gov](http://osrp.lanl.gov)**

- Register unwanted transuranic and selected beta, gamma sources with OSRP for recovery consideration.
- OSRP source recovery operations are generally prioritized on the basis of activity and level of security.
- Where numerous sources of lower activity are present at a single location, consideration is given to the total activity from a security perspective.

Sealed Sources Recovery Registration | Off-Site Source Recovery Project (OSRP) at LANL | Windows Internet Explorer provided by <http://www.lanl.gov/OSRPsources.aspx>

File Edit View Favorites Tools Help

Off-Site Source Recovery Project Sealed Sources Recovery

Sealed Sources Recovery Registration NASA

The purpose of this form is to provide a mechanism for users to register radioactive sealed sources with the Off-Site Source Recovery Project (OSRP). Please register your sources even if you want to keep them for now. A place has been provided to indicate whether or not the sources are excess (i.e., "not in use" or "unwanted"). When the form is submitted, the information will automatically be entered into the OSRP database. Once your information has been checked, you will receive an e-mail notice of acceptance. Prior to the recovery of source(s), source owners will be notified and provided a listing of documentation required by OSRP. Any questions concerning the use of this form should be submitted to the OSRP by email [osrp@lanl.gov](mailto:osrp@lanl.gov), or phone (505) 667-6701.

Site Info (Items in blue are required)

Facility Name  Department   
 Address 1  Address 2   
 City, State, Zip  Country (if not USA)   
 Directions to Site

Radiation Safety Officer Contact Information

First Name <input type="text"/> Last Name <input type="text"/> Copy RSO Info to Contact?	First Name <input type="text"/> Last Name <input type="text"/> Phone <input type="text"/>
Phone <input type="text"/> Fax <input type="text"/> E-Mail <input type="text"/>	Fax <input type="text"/> E-Mail <input type="text"/>

Enter sources on next page

