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THE OFF-SITE SOURCE RECOVERY PROJECT AT LOS ALAMOS

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ABSTRACT

Los Alamos National Laboratory (LANL) has identified over 6,000 radioactive sealed sources currently licensed in the US that are neither needed nor wanted by their owners. Most of these sources contain transuranic isotopes in quantities greater than those allowed for current disposal pathways. These sources, along with an additional 12,000 estimated to become excess over the next 5 to 10 years, were made the responsibility of the US Department of Energy (DOE) for ultimate disposal under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (PL 99-240). This paper describes the plans and accomplishments of the Off-Site Source Recovery (OSR) Project at LANL. The Project is organized under the Environmental Science and Waste Technology (E) Division to address DOE's obligations for unwanted sealed sources that exceed the limits of Class-C low-level waste. The paper discusses the group's new management philosophy, the scope of the unwanted sealed source problem that LANL will face, and the proactive approach that the OSR Project is taking to reduce the risk posed by these sources in the public and private sectors. In addition, the paper presents the schedule for reducing the backlog of unwanted sources in the US. Recognizing the current reality of unresolved disposal pathways, the paper also discusses mitigating the impact that recovered sources with no identified disposition path will have on the designated storage facility at LANL.

INTRODUCTION

Since 1979, Los Alamos National Laboratory (LANL) has accepted unwanted Pu-239/Be neutron sources from licensees and US Department of Energy (DOE) sites for final disposition. By 1998, LANL had recovered over 1,100 sources under a program funded by DOE Defense Programs (DP) that destroyed the sources, recovered the isotope by chemical processing, and stored recovered materials as Pu oxide. However, chemical processing was expensive (>$20,000 per source) and limited (a source-processing capability of no more than 80 to100 per year). Potential commingling of defense and nondefense waste was another problem that created complications for disposal of the waste. Further, a significant amount of additional process waste was produced by chemical destruction of the sources. Beginning in 1994, DOE Environmental Management (EM) at DOE headquarters (HQ) began supporting LANL's efforts to extend this source-processing technology to Am-241/Be and Pu-238/Be in order to find cheaper, more efficient processing techniques that would address the full range of sealed sources that will one day require recovery. By the end of FY 1998, these efforts had not produced a viable capability, and further efforts for processing unwanted actinide-bearing sealed sources were halted.

At the beginning of FY 1999, DOE-Albuquerque (DOE-AL) Waste Management Division (WMD) assumed management of three DOE EM programs, all operated by LANL, that had previously been managed directly from DOE-HQ: the Off-Site Waste (OSW) Program, the Radioactive Source Recovery Program (RSRP), and the Pu-239/Be Neutron Source Recovery Program. At the time of this transition, the HQ Program Manager had requested a reevaluation of these programs. Throughout the first quarter of FY 1999, DOE-AL/WMD examined alternative

management strategies that would meet the needs of the DOE, primarily compliance with the Low-Level Radioactive Waste Policy Amendments Act of 1985 (PL99-240) and the subsequent DOE report to Congress[1]. The following series of events summarizes what was learned.

Original Assumption: DOE-AL/WMD assigned LANL E-Division to revisit the original assumptions used when evaluating the *chemical processing* methodology for dealing with the class of unwanted actinide-bearing sealed sources that posed the highest level of concern. Findings suggested that the assumptions used in the Options Analysis of 1995[2] that had prompted the selection of a processing management scheme – rather than acceptance and storage until direct disposal – were no longer valid. These original assumptions were as follows.

- Sources accepted by DOE before FY 2000 will require storage for 20 years before gaining access to a disposal site. *Note: At the time, the DOE National Low-Level Waste Program had identified the High-Level Waste Repository (presumed to be Yucca Mountain) as the preferred disposal alternative.*

- US Department of Transportation (DOT) Special Form Certification does not exist for most of the sealed sources requiring acceptance by DOE. Therefore, Type B transport containers (typically 30-gallon 6M drums) will be required. Also, neutron shields are not acceptable in DOT Specification 6M drums. *Note: This assumption implied that considerations of radiation dose rates during transportation would limit the activity of a typical shipping package used for source recovery to 1 or 2 small sources (3 to 5 curies in the case of neutron emitters).*

- Long-term storage of sources is assumed to consist of shelf storage of sealed sources in their respective 6M Type B shipping containers within a warehouse-type high-bay light metal building. *Note: This assumption implied that workers would be required to place drums in the storage facility and work in and around an increasing number of drums, which might finally accumulate to a total of several thousand drums over a 20-year period. The radiation dose emitted from any single drum would vary from 1 to 10 millrem (mrem) measured 1 meter from the surface.*

Changes: The following new information changed the implications of these original fundamental assumptions.

- The DOE HQ Program Manager responsible for Greater-Than-Class C (GTCC) disposal has requested that the OSR Project reevaluate the realm of disposal options that may be applicable to sealed sources.

- Research beginning in 1997 and continuing to the present has produced DOT Special Form Certification on an estimated 90% of the sealed sources requiring acceptance by DOE. New and more detailed physical and technical information about the unwanted sources has been obtained which allows rigorous characterization in order to meet stringent waste acceptance criteria.

- Special Form qualification permits consolidated shipments in Type A containers, which can incorporate polyethylene shielding for neutron emitters. In addition, neutron shields can be incorporated into the few Type B containers required for transportation with repackaging into highly shielded Type A containers for storage. The result is the potential to consolidate sources and to reduce the total number of drums stored by as much as a factor of 10. New waste disposal criteria models for packaging, characterization, and certification are under development.

- The newly developed packaging technology, which incorporates high levels of internal shielding, will support transportation and storage and will serve as an acceptable waste package for final waste disposal.

- With a potentially large reduction in the number of containers requiring storage, the concept of a simple storage facility containing fewer drums for a shorter period of time will yield a significantly lower potential for radiation exposure to workers.

- Estimates of the total number of sources expected to need recovery are continuously updated through the comprehensive database maintained by the project at LANL.

Implications of Changes in Assumptions: When the new information described above was factored into the basic assumptions used in the program reevaluation process, it was determined that there was a high probability that changing the management approach to one of *aggressive source recovery with consolidation of sources in multifunction shielded containers for storage until disposal is made available* would have in the following effects.

- reduced risk to the public, reduced liability for DOE, and expedited compliance with PL99-240 for sealed sources;

- expansion of the range of source-types that could be addressed;

- reduced radiation exposure to workers during the recovery, transportation, and storage process;

- substantial improvement in cost effectiveness

- involvement of private industry in the management process;

- allowance for recycle and reuse opportunities for radioactive material should a programmatic need or economic pathway prove viable;

- minimization of storage and eventual waste volumes;

- quantification of waste volumes and packaging methods to support the pursuit of limited and focused disposal options in a reasonable time frame;

- a parallel path forward for excess sealed sources held under license and those held within the DOE complex; and

- elimination of secondary waste streams generated by chemical processing of sources.

Actions: These promising effects on all of the source recovery and off-site waste efforts already in progress argued for a total reconfiguration of these programs into a single project, which would be renamed the *Off-Site Source Recovery Project* or the OSR Project.

The reorganization creating the OSR Project occurred in January 1999. Management of the project at LANL was assigned to the Waste Management Program Office within E Division. There were three immediate objectives:

1. Mobilize to recover 41 sealed sources which DOE-AL had directed be recovered, based on a request from the Nuclear Regulatory Commission (NRC).

2. Develop a scope for the newly organized project, and begin the process of reconfiguring the operational structure at LANL to shift from a source processing scenario to one of recovery and storage.

3. Prepare Technical Area (TA) 54 Area G [the transuranic (TRU) Waste Storage Facility] at LANL to receive and manage the excess actinide-bearing sealed source inventory in a safe and cost-effective manner.

OPERATIONS

The first step in the project's operation was to contract with commercial facilities that had the capability to store sealed sources on an interim basis while the preparations for storage at LANL TA-54 Area G were being completed. Several shielded 55-gallon Type A shipping containers were procured to increase the number of sources that could be packaged in one container and to allow multiple recoveries to occur simultaneously. This 55-gallon Type A configuration is referred to as the OSR Project interim container, because it is the first highly shielded container to be used and will serve until the multifunction container is developed (discussed below). One of the contracted facilities was able to provide Type A shipping containers that could also be used. Several of the source owners on the NRC list had the capability to package and ship their own sources to the storage site once provided with containers. For those owners who were not capable of packaging and shipping their sources, a contract was procured with a consultant who had extensive experience in handling, shipping, and transporting Am-241/Be oil-well-logging sources. In addition, the primary interim storage facility provided qualified employees who could travel to the source owner's site and package and ship the sources.

From early February when the authorization to proceed was received, it took a little over two months to recover and place all 41 sources in interim storage. Seven of the 12 sites on the NRC list were able to package and ship or transport their sources to the storage site. Sources from the remaining five sites were packaged by contracted personnel. Figure 1 shows well-logging sources being packaged into the interim container during recovery operations at Nuclear Logging Service, Inc. in Wheat Ridge, Colorado.

At the time this paper is being written, field operations continue in response to additional NRC requests for sealed source recovery. As of January 31, 2000, a total of 90 sources have been placed in interim storage. Additional recoveries are planned to continue through the rest of FY 2000.

Fig. 1. Loading of well-logging sources into Type A shipping container.

SCOPE

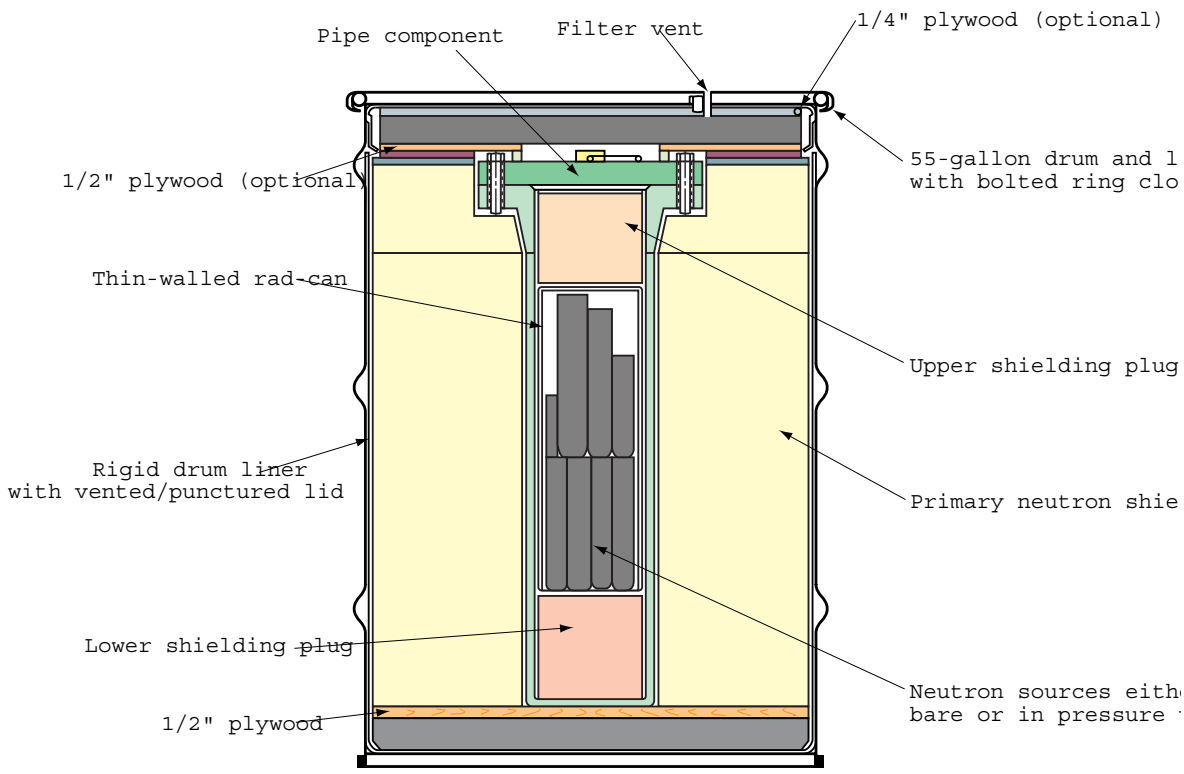
The first step in transitioning the OSR Project from a chemical processing focus to one of recovery and long-term storage was to apply emerging packaging technology to the problem of sealed sources as a waste form. In the summer of 1998, predictions of external neutron fluxes from shielded containers in a common 55-gallon drum configuration performed by the Radiation Engineering group at LANL[3] suggested that maximum US DOT A_1[4] quantities of actinides (in special form) might be readily transported and stored. These findings were empirically confirmed in the Chemistry and Metallurgy Research Facility (CMR) at LANL in the fall of 1999[5]. The conclusion was that practical payloads of excess neutron sources of 30 curies (the greatest single safety concern of the project) could be managed in shielded 55-gallon containers yielding contact dose rates of <100 mrem/hr and DOT transport indices (TIs)[6] of 6 to 8.

This conclusion suggested that a significant number of neutron sources could be safely packaged in a single drum for recovery, transport, and storage. When the use of shielded drums was

applied to the probable inventories of sources that the project might expect to see between FY 1999 and FY 2010, very modest total waste volumes resulted.

Multifunction Container Development

In 1998 a 55-gallon TRU waste container known as the Waste Isolation Pilot Plant (WIPP) *pipe component container*, developed by the Rocky Flats Environmental Technology Site, had received approval from NRC[7] for transport in the TRUPACT II transport system. This container not only provided an ideal waste form to accommodate the needs of Rocky Flats, but offered significant attractions for sealed source management: when it was fitted with appropriate neutron and gamma shielding, its utility could be extended to a promising shipping and storage container, as well as a potential waste form. This container became the foundation for development of the OSR Project *multifunction container*. The objective is to develop a shielded version of the WIPP pipe component container, which would go through the entire TRUCON (TRUPACT II Content Code) approval process, to yield a package that could accommodate disposal of eligible excess sealed sources at the WIPP. The Content Code is a uniform system applied to waste forms to group those with similar characteristics for purposes of shipment in the TRUPACT-II. The multifunction container would also serve as the basic workhorse of the OSR Project by serving first as the container used for source recovery and transport, then as a storage container, and finally as a waste form that meets all of the rigor of the WIPP model. With this concept of a multifunction container, the OSR Project could define an accepted TRU waste storage model along the lines approved for the WIPP, consolidate the inventory and, for the first time, project a realistic inventory and packaging scheme for the life of the project. A conceptual sketch of the multifunction container is shown in Figure 2. Evaluation of this container by NRC will begin with the submission of Revision 19 of the TRUCON code scheduled for February 2000.



The S100 Pipe Overpack is a modification of the WIPP 6-inch pipe-component container originally designed at DOE's Rocky Flats site, Boulder, Colorado (currently under the NRC review process as part of Rev. 19 to the TRUCON Safety Analysis Report).

Fig. 2. S100 pipe overpack multifunction container (US DOT Type A).

Estimated Waste Volumes

Using data developed by Harris, et al.[8], coupled with direct contacts with industry and an existing LANL database, the OSR Project team developed an inventory of the primary sealed source types that might be anticipated for management over the life of the project. If shielded multifunction containers are assumed in the management of this inventory, the scope of the problem can be grasped in a waste management context.

Table I provides a summary of the waste volumes resulting from the consolidation and packaging for safe and compliant storage of over 17,000 actinide-bearing sealed sources. These wastes would be classified primarily as Greater-Than-Class-C Low-Level Waste (GTCC-LLW) and would be generated from all the sources anticipated to require acceptance from the licensed sector beginning in FY 1999 and extending through FY 2010. However, the table also includes potential volumes generated by DOE sites, data which have been developed from a report prepared by the Nuclear Materials Integration (NMI) Project[9]. This additional waste stream would include wastes classified as nondefense TRU, as well as a yet-undetermined fraction of defense-TRU that would be eligible for disposal at the WIPP.

TABLE I. Summary of Estimated Waste Volumes (GTCC-LLW)

CATEGORY	Watts/ Drum	Activity/ Drum (Ci)	Surface Dose/Drum	Dose at 1 meter	Drums for Disposal by 2010	Volume for Disposal by 2010 (m^3)
^{241}Am/Be Well Logging Sources	0.96	30	66 mrem/hr	7.2 mrem/hr	554	110.8
^{238}Pu/Be General Neutron Sources	0.1	30	66 mrem/hr	7.2 mrem/hr	112	22.4
^{239}Pu/Be General Neutron Sources	0.30	13.2	21 mrem/hr	2.33 mrem/hr	66	13.2
^{238}Pu Medical Sources and Small Heat Sources	1.64	50	<10 mrem/hr	<2 mrem/hr	90	18
^{241}Am Calibration Sources	<0.1	1.65	<10mrem/hr	<2 mrem/hr	11	2.2
^{241}Am/Be General Neutron Sources	1	30	66 mrem/hr	7.2 mrem/hr	53	10.6
^{241}Am/Be/^{137}Cs Portable Gauges	<1	5.0/1.0	11 mrem/hr	1.2 mrem/hr	5	1
^{241}Am/Be Portable Gauges	0.54	9	50 mrem/hr	6.5 mrem/hr	5	1
^{241}Am Fixed Gauges	0.34	10.5	<50 mrem/hr	<5 mrem/hr	12	2.4
Totals					**908**	**181.6**

This table does not include Cf-252 sources which are believed to have direct recycle value. A very large (2,200 Ci) single Am/Be source at Oak Ridge National Laboratory is also not included here; it is considered an anomaly that will be addressed separately.

These volumes are only estimates and can be expected to change as better data and more specific packaging plans are developed. For purposes of comparison, however, these actinide-bearing sealed source waste streams would total less than 200 cubic meters of packaged volume. Should the WIPP disposal avenue present itself at some time in the future, this would amount to only about 22 TRUPACT II shipments to WIPP.

Table II summarizes a projected rate of consolidation and acceptance of sealed sources from the licensed sector over the planned course of the project in terms of drums. The table shows the number of drums expected to accumulate in storage until 2006. For planning purposes, it is assumed that some form of disposal option might become available in 2006, permitting shipments to a disposal site to commence. Following 2006, long-term storage is assumed to be unnecessary. The rate of recovery and acceptance is based on a plan to work off the total backlog (reduce all major risk by 2006). If this assumption proves realistic, the period between 2006 and 2010 would become a transition period during which LANL would phase out of source recovery and storage operations, leaving all continued operations to be carried on directly between source owners and the disposal facility.

TABLE II. Summary Sealed Source Acceptance and Disposal Schedule

Fiscal Year	99	00	01	02	03	04	05	06	07	08	09	10	Total
Drums Accepted/Yr	0	61	95	100	109	124	109	89	64	59	55	43	**908**
Drums in Storage		61	156	256	365	489	598	387	151	0	0	0	
Shipped for Disposal	0	0	0	0	0	0	0	300	300	210	55	43	

The data in Tables I and II suggest that interim storage of the entire projected sealed source inventory as a waste form will have a minor impact on a storage facility.

STORAGE

The TRU waste storage facilities at LANL are under the custodianship of DOE-DP and serve as the primary support to LANL's foremost defense mission. It was necessary to determine the potential impacts that the total projected OSR Project inventory might have on that facility.

Potential impacts on DP operations and requirements at Area G derived from acceptance of the OSR Project waste stream take two forms. First is the DOE programmatic commitment required to fund the OSR Project and the resulting "mortgage" in the form of a managed inventory accumulated at Area G. Second are the operational impacts on Area G that acceptance, storage, and monitoring of the OSR Project inventory would create over the expected ten-year life of the project. The first potential impact has been addressed by written commitments made both from DOE-HQ and between WMD and the Nuclear Programs Division (NPD) within DOE-AL. The second potential impact is addressed as follows:

Current estimates by LANL Facility and Waste Operations Division – Solid Waste Operations (FWO-SWO) personnel place the total accumulated TRU waste volume at Area G at over 44,818 drum-equivalents, including newly generated DP wastes that arrived in FY 1999. The strategic plan at LANL calls for this inventory to be disposed by two mechanisms:

1. direct shipments to WIPP as newly generated and legacy drums are characterized and certified (begun in FY 1999) and

2. a decontamination and volume reduction system (DVRS) for large items, with some fraction of the total volume of TRU converted to LLW for direct burial at Area G and the volumetrically reduced balance of TRU going to WIPP.

Over the next two decades, these disposal paths will be pursued until a steady-state is reached at Area G in which TRU wastes generated at LANL are expeditiously packaged and transshipped to WIPP and no long-term inventory of TRU waste remains in storage at Area G. This process was begun in FY 1999 with the shipment of the first 30 drums of TRU waste to WIPP and is expected to continue through 2010 when equilibrium will be achieved.

The total estimated consolidated inventory of sealed sources recovered by the OSR Project over the next 10 years varies depending upon the assumptions taken into account, as discussed above. However, assuming the OSR Project will accumulate the volumes shown in Table II, the operation of the site can be charted. Figure 3 shows the projected receipt schedule of the OSR Project waste stream at Area G over the life of the project, plotted against the perspective of the planned routine drum-equivalent shipments of new and legacy waste to WIPP during the same period. This was done to offer some perspective of the OSR Project annual impact.

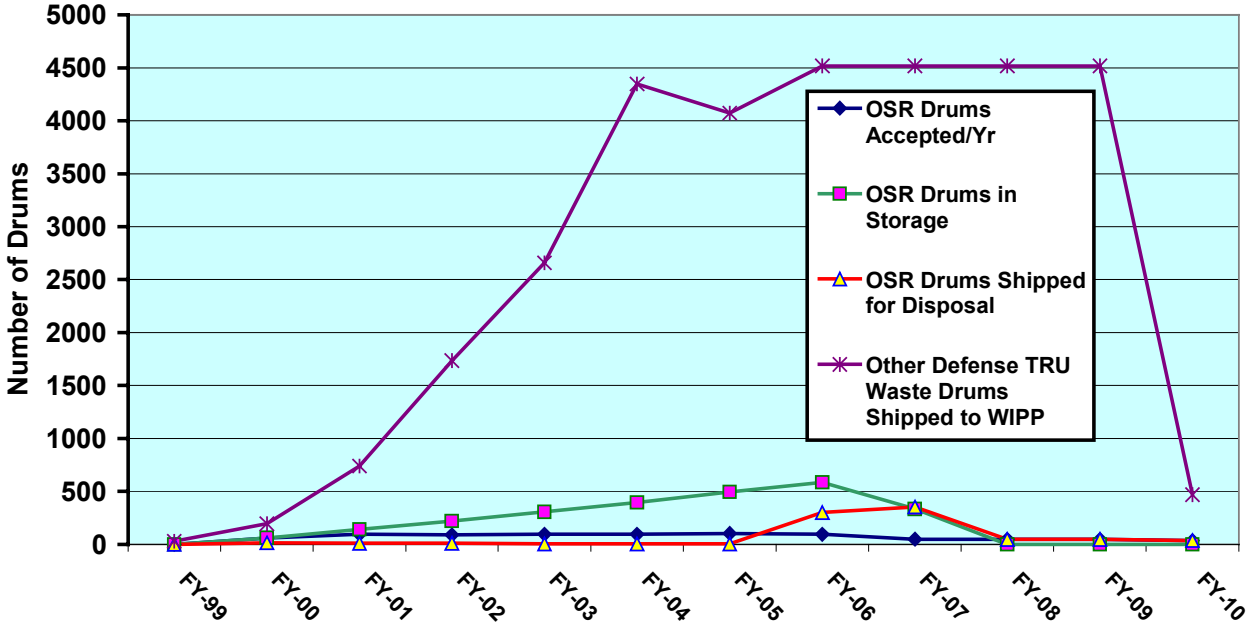


Fig. 3. Perspective of OSR Project Volumes at TA-54 Area-G.
(Points on the graph represent discrete quantities for each year shown. However, they have been connected to suggest the continuous annual effect of the operation.)

The inventory received each year from the OSR Project is expected to contain excess sealed sources from the licensed community as well as from other DOE sites. It is anticipated that 5 to10% of the inventory received will have a sufficient defense pedigree to permit WIPP disposal. Figure 4 shows the fraction of the OSR Project inventory that will be transshipped to WIPP. It is very small. However, drums containing sources that are not WIPP eligible will accumulate at Area G and reach a peak in FY 2006 of about 600 drums in storage. Included in OSR Project plans is a projection that a disposal option will become available in FY 2006, which would permit the transshipment of the OSR Project inventory to begin that year. The figure (4) shows the transshipment process reaching the steady-state of zero long-term inventory for the OSR Project in 2008. Should disposal not become available in FY 2006, the total inventory in storage would increase to 867 drums by 2010.

Figure 4 reflects the scale of all TRU waste operations at Area G over the next decade. This chart shows the planned de-inventory of TRU wastes from Area G based on current LANL projections involving direct shipments to WIPP. The chart also shows the impact of planned reduction in TRU waste at Area G resulting from the decontamination and volume reduction

system. The chart in Figure 4 also includes the annual addition of approximately 165 cubic meters of newly generated TRU waste that is generated annually from DP programs at LANL beginning in FY 2000. The first obvious feature of this figure is that, when viewed within the full scale of TRU operations at Area G, the receipt of drums from OSR Project activities is barely quantifiable. The total projected activity of the OSR Project in FY 2000 would be the receipt of 61 drums, which is only about 30% of what is planned to be shipped to WIPP in FY 2000. By the time the OSR Project accumulates its projected maximum inventory at Area G in FY 2006, Area G will contain less than half of its current inventory, with the balance already removed and shipped to WIPP based on current projections. There are no projections of DP program activity that would significantly change this trend.

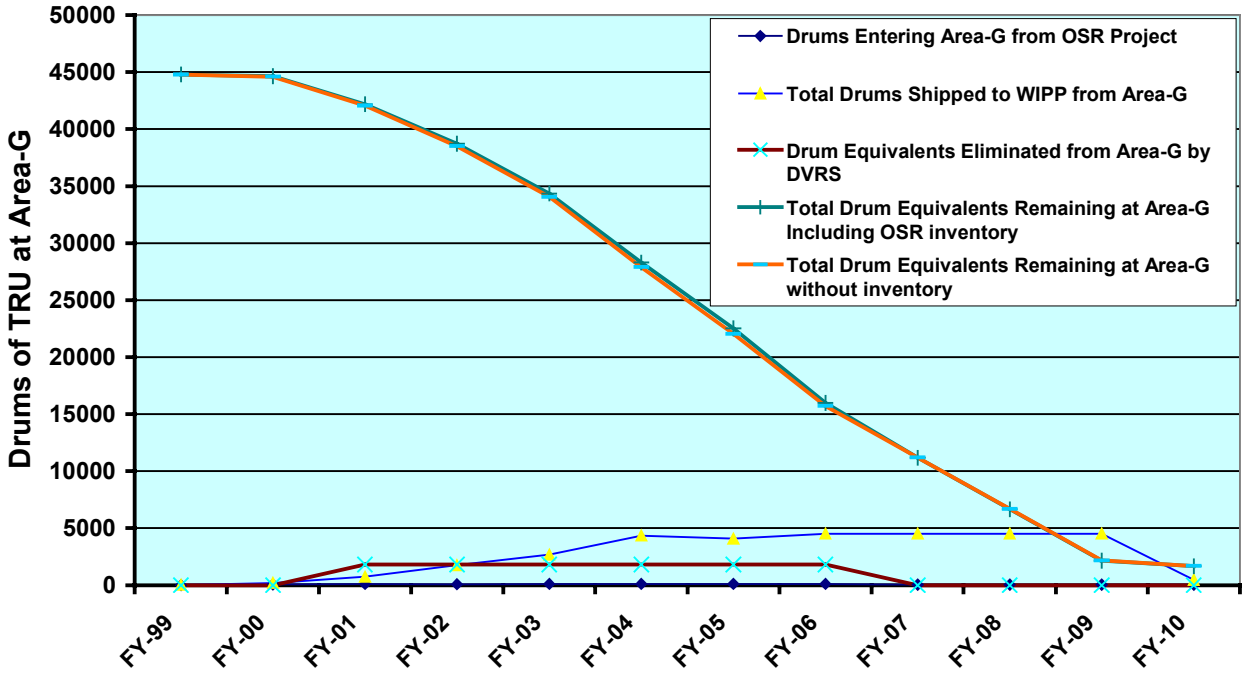


Fig. 4. OSR Project Impacts on TRU Volumes at TA-54 Area G.
(Points on the graph represent discrete quantities for each year shown. However, they have been connected to suggest the continuous annual effect of the operation.)

Figure 4 also shows the annual inventory of TRU waste in storage at Area G both including the OSR Project inventory and excluding it. When viewed on the scale of overall TRU waste operations at Area G, these two lines show insignificant separation, suggesting that OSR Project operations have no significant effect in any regard on operations at the site.

CONCLUSION

The mission statement for Los Alamos National Laboratory includes the reduction of the global nuclear danger through nuclear materials management and environmental stewardship. The OSR Project at LANL speaks directly to these primary mission elements. Accumulation of large

numbers of excess and unwanted high-activity radioactive sealed sources within the US has created a domestic nuclear threat to the health and safety of people and the environment. The reorganization of sealed source recovery activities at LANL has been directed toward improving the speed and efficiency by which that threat might be addressed in a programmatic context on behalf of DOE. Under the OSR Project as described in this paper, the scope of the sealed source problem in the US has been reduced to manageable dimensions for risk reduction, cost, operational complexity, and overall project duration. It remains now to be seen whether or not the plan can be successfully executed and the risk reduced in a timely manner, before the threat manifests itself in a serious incident.

REFERENCES

1. *Recommendations for Management of Greater-Than-Class-C Low-Level Radioactive Waste, Report to Congress in Response to Public Law 99-240,* US Department of Energy, Assistant Secretary for Nuclear Energy, DOE/NE-0077 (February 1987).
2. Leonard, L. E., D. Bailey, J. A. Tompkins, *Radioactive Source Recovery Program Management Options Summary*, LANL. Prepared for and submitted to Robert Campbell DOE Headquarters (January 1995).
3. Unpublished data provided by T. Brown, Group ESH-12 of the Environment, Safety, and Health (ESH) Division, Los Alamos National Laboratory (July 1998).
4. The A_1 quantity means the maximum activity of special form Class 7 (radioactive) material permitted in a Type A package per 49 CFR 173.403.
5. Unpublished data developed by J. A. Tompkins and L. E. Leonard (November 1998), LANL.
6. The transport index (TI) means the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation per 49 CFR 173.403.
7. TRUPACT-II Safety Analysis Review, Appendix 1.3.11 *Description of Pipe Overpack*, Rev. 17, DOE Carlsbad, NM (August 1997).
8. Harris, Gerald, *Characterization of Greater-Than-Class-C Sealed Sources, Volume I: Sealed Sources Held by Specific Licensees,* Idaho National Engineering Laboratory, DOE/LLW-163 (September 1994).
9. *Nuclear Materials Stewardship Program Materials Management Plan for Nonactinide Isotopes and Sealed Sources (NISS)*, G. D. Roberson, US Department of Energy, Albuquerque Operations Office, Draft Rev.0 (December 1998).