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Author(s):	J. A. Tompkins
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An Ideal Sealed Source Life Cycle

J. Andrew Tompkins

Problem

In the last 40 years, barriers to compliant and timely disposition of radioactive sealed sources have become apparent. The story starts with the explosive growth of nuclear gauging technologies in the 1960s. Dozens of companies in the U.S. manufactured sources and many more created nuclear solutions to industrial gauging problems. Today we do not yet know how many Cat 1, 2, or 3 sources there are in the U.S. There are, at minimum, tens of thousands of sources, perhaps hundreds of thousands of sources[1]. Affordable transportation solutions to consolidate all of these sources and disposition pathways for these sources do not exist.

The root problem seems to be a lack of necessary regulatory framework that has allowed all of these problems to accumulate to with no national plan for solving the problem. In the 1960s, Pu-238 displaced Pu-239 for most neutron and alpha source applications. In the 1970s, the availability of inexpensive Am-241 resulted in a proliferation of low energy gamma sources used in nuclear gauging, well logging, pacemakers, and X-ray fluorescence applications for example. In the 1980s, rapid expansion of worldwide petroleum exploration resulted in the expansion of Am-241 sources into international locations. Improvements of technology and regulation resulted in a change in isotopic distribution as Am-241 made Pu-239 and Pu-238 obsolete. Many early nuclear gauge technologies have been made obsolete as they were replaced by non-nuclear technologies. With uncertainties in source end of life disposition and increased requirements for sealed source security, nuclear gauging technology is the last choice for modern process engineering gauging solutions.

Over the same period, much was learned about licensing LLW disposition facilities as evident by the closure of early disposition facilities like Maxey Flats. The current difficulties in sealed source disposition start with adoption of the NLLW policy act of 1985, which created the state LLW compact system we have today. This regulation created a new regulatory framework seen as promising at the time. However, now we recognizes that, despite the good intensions, the NLLWPA85 has not solved any source disposition problems.

Comment [JMG1]: Should define all acronyms the first time they appear.

The answer is to these sealed source disposition problems is to adopt a philosophy to correct these regulatory issues, determine an interim solution, execute that solution until there is a minimal backlog of sources to deal with, and then let the mechanisms we have created solve this problem into the foreseeable future.

The primary philosophical tenet of the ideal sealed source life cycle follows: You do not allow the creation (or importation) of any source whose use cannot be justified, which cannot be affordably shipped, or that does not have a well-delineated and affordable disposition pathway.

Solution

The path forward dictates that we fix the problem by embracing the Ideal Source Life cycle. In figure 1 we can see some of the elements of the ideal source life cycle. The life cycle is broken down into four portions, manufacture, use, consolidation, and disposition.

<<INSERT FIGURE 1>>

[1] *Transportation Safety Risk for Source Recovery vs. Consequence of Leaving Radioactive Sources In Place and Vulnerable Due to Limited Transport Options or Denial of Shipment*, Griffin, J.M., Leonard, L.E., PATRAM 2007, October 21-26, 2007, LA-UR-07-6961.

These four arbitrary elements allow us to focus on the ideal life cycle phases that every source should go through between manufacture and final disposition. As we examine the various phases of the sealed source life cycle, we will pick specific examples and explore the adoption of the ideal life cycle model.

MANUFACTURE, DESIGN, AND DISTRIBUTION

Special Form Records: Starting with the manufacturing phase, we can see the design, testing, and evaluation of sources with respect to national standards[2] is very important. The second element is registration of sources as special form with the USDOT. If a source containing an (activity greater than A_2 quantity) needs to be shipped as special form internationally then USDOT (PHMSA) needs to evaluate test data and issue a Certificate of Competent Authority (COCA). One aspect of this commercial activity is that sources that were never shipped internationally may still be shipped domestically in the U.S. as self-certified special form sources. If the manufacturer goes out of business then the testing records that were construed as the basis of self-certification are lost. The solution is simple, all special form test data must reside with DOT, whether or not a COCA is issued, or a designated Type B container that is affordable must be available to transport this model of sealed source. Many of the problems with special form character documentation that we see today are the result of changes in regulation between 1970 and 1974 when special form sources became a necessity for activities greater than the A_2 value

The other aspect of this special form problem is the recommended working life (RWL) of a source. If the manufacturer has an RWL of 15 years for a source, then the regulator (DOT) is going to avoid classifying a source as special form when the manufacturer is stating the source should only be used for a fixed period. If a special form source is going to become normal form, a decision needs to be made as to when to retire the source from service. The license for the source should require that sources serving beyond the RWL have a known and affordable transportation option. The error here is not making the licensee make a decision before the source becomes normal form and extraordinary actions are needed to move a single source.

SSDR: The sealed source and device registry (SSDR) evaluation of sources and devices is one part of the ideal life cycle philosophy that functions well. The purpose of the SSDR system is to justify the use for source or device, to evaluate function, and to document the basic information. It is a written record that summarizes pertinent data on sources and devices. The records are available to governmental users on-line. The only two improvements that could be made follow: One minor piece of information the SSDR is missing pertains to the special form character of the source. Even though it is the DOT's responsibility to issue a COCA, the NRC's SSDR evaluation should document the special form character of the source (under prototype testing) if it exists.

Another problem is that source and device manufacturers need access to the SSDR database. After the 9/11 attacks only governmental entities retained access to this information. There are times when a manufacturer needs information about other manufacturers' products. If the purpose of the SSDR exclusion is to keep radioactive material abusers from using the information to facilitate their activities, then I would submit that most source manufacturers (Cat 1, 2, and 3) could be counted on to use the information for approved purposes.

Comment [JMG2]: Papers should avoid the use of first-person (I, me, we, us, etc.).

Material Registration: One non-nuclear aspect of the end of life for sealed sources is the origin of the radioactive material. This is of grave consequence when considering a final disposition of a radioactive material in that most disposal sites are very concerned about inorganic, non-radioactive impurities in source material. This consideration is caused by the potential use of Resource Conservation, and Recovery

[2] ANSI/HPS, N43.6-1997 Sealed Radioactive Sources - Classification

Act (RCRA) authority to regulate radioactive waste disposition sites. When material is purchased from a source of the particular isotope then a certificate of origin of the material needs to be recorded, filed, and maintained as a record to eliminate this much after the fact issue.

With the demise of portions of the U.S. sealed source industry we are now importing significant quantities of Am-241, Cs-137, and Co-60 from off shore. If the material is imported, the RCRA content information needs to be received and recorded from the foreign entity distributing the isotopic material. This information will only be needed at the disposition phase of the ideal source life cycle

Manufacturing Records: When a sealed source is manufactured, a record is typically generated that details the activity, isotope, date, model, and buyer of a sealed source. This record is called a production log. When the sealed source is sold, a source certificate accompanies the source during the distribution phase. These manufacturer's records are of incalculable value in the final disposition phase of the life cycle. As long as the manufacturer is in business, access to these records is not a typically not a problem. However, when the manufacturer goes out of business, these primary records sublimate like snow in the desert. The regulatory entity must capture these records to facilitate final disposition. If you cannot certify what a source is, where it came from, and who made it; then how can you offer any final disposition for these radioactive sealed sources. What a wonderful world it would be if the source certificates and production logs from Monsanto Research Corporation had been captured during the license termination phase of that business in the 1980s

Inventory: Only when a state and ultimately a national inventory of radioactive sealed sources exist can we, as a nation, pretend to manage our sealed sources. The USNRC has begun the work of assembling a U.S. inventory of sealed sources and devices (Cat 1 and 2). By 2010, they should have a fairly complete inventory for Cat 1 and 2 devices. Now if they only knew the model number and manufacturer of those devices or for all Cat 1, 2, and 3 sources this would be a perfect part of the life cycle. Management of sources by licensed device allows evaluation of the adequacy of means of transport and determines whether we can afford to make obsolete older shipping packages or to allow DOT COCA for special form character to lapse.

Security: The recent implementation of security protocols has decreased relative risk at some licensee facilities and greatly increased the demand for affordable transport and disposition of marginally employed Cat 1 and 2 devices. This particular regulatory stress coupled with the loss of many Type B packages has exacerbated the sealed disposition issue in the U.S. as no other recent occurrence could. Security commensurate with risk (threat) for continued storage or transport should always be a consideration of source and device distribution.

Distribution: If the source was manufactured, then it can be assumed that there will be a need to distribute the source or device. Many larger devices have unique characteristics; size, weight, shape, activity that allow the use of only one or two shipping packages. The availability and affordability of these shipping packages must be maintained if we really believe that there will be a final disposition of these devices (sources) in the future.

The Design, Manufacturing, and Distribution side of source production will only support the disposition side of the ideal life cycle if information is collected and retained in ways designed to support final disposition. The availability of good documentation will always work to the advantage of final disposition. The lack of good documentation will always cause uncertainty and increase risk (cost), which directly affects affordability. Affordability is always the barrier to appropriate disposition. If we do not manage

the regulatory life cycle and provide appropriate disposition pathways, uncertainty will always increase costs and create a barrier to affordability.[3]

SOURCE USE

Sealed sources have been in use in the U.S. since the 1920's, when radium needles made their first appearance. The licensing of sealed source use is well regulated and documented. When I request source records from regulators I typically get licenses, inspections, notices of violation, anything but a source record.

Records Retention: When we collect sources from a licensee's site, only about 5% have a file with a source certificate. Retention of source records by licensees needs to be mandatory.

Financial Surety: This particular topic is typically invoked when dealing with source manufacturing sites where the potential for cleanup costs at the end of corporate life could easily exceed the value of the commercial property that remains. There is another potential aspect of surety that could be applied to the end of an ideal source life cycle. The concept of surety is being used in many countries to mean that the government which regulates licensees and disposal sites also will solve the radioactive material disposition problem by taking your source for a fixed price. Sealed source take back programs are seen in developed (France) and developing countries the world over. The idea of take back is that, for a small fee ($50 for a source or $5k for a teletherapy head), society can insure that the cost of consolidation and final disposition are known to all and will not inhibit the licensee from responsibly dispositioning his sources and devices. I have been told that we will not do this in the U.S., I'm just not sure why removing the uncertainty, and lowering the expense is not a good idea.

CONSOLIDATION

Need for Consolidators: Consolidation is a necessary part of source disposition in that the more sources that are available for disposal at one time, the lower the unit cost of the final disposition will be.

In ten years of sealed source recovery, OSR Project has recovered 20,000 sources. If every one of those recoveries had been limited to 2-3 sources at a time, we would have only recovered a few thousand from a cost and manpower perspective.

Return to Manufacturer: The fact that some manufacturers will accept their obsolete devices (sources) for consolidation is of business necessity. It is impossible to sell new units if you will not recover the old. However, the accumulation of old nuclear gauges is a corporate financial liability if there is no disposal path. This was illustrated quite succinctly in 2003 when we discovered that moisture density gauge manufacturers were no longer accepting combination sources (AmBe/Cs-137 in one capsule, known as a combi-source). When we questioned the practice the manufacturers pointed out that they had reached the limit of corporate liability for that one type of source, and that when the government provided an outlet for their combi-source inventories they would resume combi-source consolidation. Over the next year, OSR Project developed a plan and began dealing with these problem sources.

Packaging: In an ideal world we maximize the number or activity of sealed sources per disposal package. This is done to minimize the per unit cost for disposition. Packaging for disposition is optimal when it is performed one time to keep doses ALARA and labor cost to the absolute minimum. To package for disposition, it is necessary to know the Waste Acceptance Criteria of the disposition site and the needs of

[3] Health Physics Society Discussion Paper, "Actions Needed to Better Secure Vulnerable Radioactive Sources: A Contemporary Report", Sept. 8, 2005.

the waste certification official for the disposition package. Optimal performance in this area lends itself to well established disposition pathways.

Affordability: The take back programs of the South American nations are a foreign example of affordability. When I inquired about pricing with one of my colleagues I was told $50 for a simple gauge and several thousand for a teletherapy head. To my mind, this was the most absolute bare bones example of affordability. The costs are not excessive; they do not create a barrier to disposition. It is in the public interest for health, safety, and security that sources move down the disposition pathway when they are no longer needed.

Guaranteed Disposition: Why would you license a source for manufacture, distribution, and use if you do not know for certain what the distribution pathway entails. For transuranic sealed sources, there was no pathway for disposition from 1985 – 2001, when the Off-Site Source Recovery Project began regular recoveries of Pu-239, Am-241, and Pu-238 sealed sources. Other than recycle of large AmBe sources for the well logging industry (> 5 Ci), there is no other U.S. disposition pathway for these sources. What was found in 1990-2000, was that inventories of excess TRU sources languished all over the country because of a lack of disposition.

Transportable: If the sealed source world were truly ideal, all sealed sources owners of less than A_1 or A_2 quantities of activity would be able to self ship these units to a consolidation site. However, that would require that at the end of life a source or device the source must be shippable, by whatever method got it to the customer to start with. If it costs $100,000 to move a $20,000 self-contained irradiator, then the device is not shippable. See **Affordability** above.

This means that prior to relinquishing special form CoCA on sources or making Type B containers obsolete, the regulator needs to ask itself how many units are being stranded in the public sector that will now cost exorbitant sums to transport – much less disposition. See need for current sealed source **Inventory** above of sources and devices by manufacturer. Even better if a licensee hold a source whose transportability is about to be terminated, perhaps they should be informed of such, this would require a much more interactive relationship with licensees and transport regulators than currently exists.

Documentation: The need for documentation is not new. With the litigious nature of our society, it is not surprising that entities accepting radioactive sealed sources for disposition need paperwork. After all paper is a form of shielding (for litigation) The waste acceptance criteria of various disposal sites vary from the rigorous visual examination and acceptable knowledge practices of NNSA[4] (WIPP) to the simple certification of content for Ra-226 disposal. Modern RCRA avoidance argues for a modicum of knowledge about the source or device model and markings. This paper trail should be maintained at least 10 years after the source is in the ground or the disposal site closed.

Consolidation Pathway to Disposition: The consolidation of sealed sources really only works well when the conditions of acceptance for consolidation and final disposition are known. Everyone will recognize the opportunity for creation of a legacy of sealed sources with no disposition pathway. Off-site source recovery is prohibited from accepting sources that are not dispositionable.

DISPOSITION

A large spoke in the wheel of an ideal sealed source life cycle is the availability of affordable final disposition. Just like Consolidation above, Disposition requires documentation, packaging, transportation, and an affordable disposal site that is licensed for the particular sealed sources needing disposition. Since

[4] Peer Review report on Documentation for Acceptable knowledge for of TRU sealed Sources.

TRU sealed sources are currently being dispositioned at the NNSA WIPP site, we will not discuss this pathway in detail. Instead, we will focus on the low-level waste pathway for beta/gamma sealed sources.

Since 1985 and the adoption of public law 94-240 (National low Level waste Policy Act), we have had a system of state participant waste compacts responsible for siting new LLW disposal areas. To date no new disposal sites east of the Mississippi river have been sited.

The only new disposal site is in Texas with a very limited compact (Texas and Vermont) and Federal Agency use. The 34 eastern states left without an LLW pathway for their radioactive sealed sources. If, after 24 years, we do not surmise that something is wrong with the regulatory framework, then perhaps we are missing the point. Without a known and reliable disposition pathway, an ideal sealed life cycle cannot exist. Licensees will hold sealed sources until they go bankrupt or disposition pathways become available as the Federal government moves to recover and dispose of unwanted sources, as a risk reduction measure.

The current OSR Project exists because the Congress specifically designated the Department of Energy as the disposer of Greater-than Class-C (GTCC) radioactive material and TRU sealed sources were the first and most obvious of those pathways needing help. However, what about Cs-137, Sr-90, and Co-60 sealed sources? Should Federal resources be expended on consolidation and disposition of beta/gamma sealed sources (large and small)?

If you believe in the ideal sealed source life cycle, then the answer is emphatically, "yes!" It will be many years until the entire U.S. has access to licensed LLW or GTCC disposal. In the interim, it is the responsibility of government to guarantee the final disposition of radioactive sealed sources that are licensed for use in the public sector.

If DOE/NNSA is going to be expected to recover, consolidate, transport, and disposition all beta/gamma sources in the U.S. using Federal resources, then they should be specifically authorized and funded by the Congress for this activity. Today, there are administrators in the U.S. government concerned that NNSA is not fully authorized for this activity. This interim pathway needs to be made explicit until a point in time when the state compact system is marginally functional. A new DOE GTCC disposal facility is being touted as the final solution to sealed source disposition. It will be many years (e.g., 2015-2020) before a new disposal site is available.

The same tenets that applied to transportation and consolidation above flow down to Disposition Affordable, documentable, transportable, consolidatable, one time packaging, known, guaranteed disposition pathway are all part of the ideal life cycle. Whether it is a state licensed disposal site or a Federal resource used as an interim measure, it makes no difference to the licensee or most state regulators as long as the sources move to a proper location when they are unwanted. The only people it truly makes a difference to are State LLW Compacts trying to collect export fees on LLW for which they do not intend to provide a disposition pathway.

SUMMARY

In summary, the ideal sealed source life cycle demands only one basic tenet. "Do not allow the manufacture and distribution of sealed sources for which, the regulatory framework is not complete. If the system that exists today does not seem "ideal," then change the regulatory framework to a common sense approach that has known pathways, with known and affordable costs.

The price of uncertainty in these sealed source control pathways is high. The price of unknown disposition resources will eventually catch up with our ability to control these necessary but hazardous items. The time to act is now. The changes needed are well understood. Everyone wants a "cradle to

grave sealed source life cycle," but who will be the first to make all of the changes necessary to make the world safe from sealed sources for us and our posterity

The biggest part of the U.S. sealed source problem is how to compel licensing, transportation, and disposition regulatory elements to integrate their requirements and work together. Only when all elements regulating sealed sources in the U.S. are working toward the same goal, will we achieve an ideal sealed source life cycle