Commercial Sealed Sources and Timely Disposal: Challenges and Incentives – 15456

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ABSTRACT

It is widely accepted as a radioactive material management best-practice that storage of disused sealed sources should be a temporary measure. Effective end-of-life management, including timely disposition of disused and unwanted sealed sources, is an important way to address national security, public health, and safety concerns presented by long-term storage of disused sealed sources. However, significantly increased disposal access since 2012 has not led commercial sealed source generators in the U.S. to dispose of their disused and unwanted sources as quickly as many had expected. As a result, policymakers and non-government stakeholders are considering ways to incentivize sealed source generators to make more timely decisions regarding the disposition of their disused and unwanted sources. To help ensure that ongoing efforts to develop sealed source management and disposal incentives are efficient and effective, NNSA/GMS is engaging both public and private sector partners to better understand generator considerations, motivations, and challenges with regard to sealed source management and disposal decisions. The results of these engagements to date indicate potentially effective ways to encourage sealed source waste generators to disposition their sources in a timely fashion.

INTRODUCTION

It is widely accepted as a radioactive material management best-practice that storage of disused sealed sources should be a temporary measure. [1, 2, 3, 4, 5] A recent Federal interagency task force report on sealed source security noted that "licensees are less likely to keep track of disused and unwanted sources than sources that are still in use," and that "[d]isused sources in storage are more likely to become lost, stolen, or abandoned."[2] While portable devices, such as

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[2] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 1.

industrial gauges and well-logging sources, may remain in secure storage for limited periods between uses, devices which have no further use or economic value to a licensee should be properly disposed when disposal access is available. Effective end-of-life management, including timely disposition of disused and unwanted sealed sources, is an important way to address national security, public health, and safety concerns presented by long-term storage of disused sealed sources.

Significantly increased disposal access since 2012, however, has not led commercial sealed source generators in the U.S. to dispose of their disused and unwanted sources as quickly as many had expected. As a result, policymakers and non-government stakeholders are considering ways to incentivize sealed source generators to make more timely decisions regarding the disposition of disused and unwanted sources still in their possession, including consideration of financial assurance and other cost-planning mechanisms which encourage disused source disposition. To support these efforts, the NNSA Office of Radiological Security (RS) (which includes part of the former Office of Global Threat Reduction or GTRI) is engaging stakeholders to determine what types of incentives, including regulatory mechanisms and information sharing, may be most effective in encouraging generators to dispose of sealed sources no longer in use.

SEALED SOURCE DISPOSAL ACCESS AND TIMELY DISPOSAL

Disposal of disused radioactive sealed sources in the U.S. has long been a challenge. Commercial disposal facility access restrictions and radioactivity limits have left many types of disused sealed sources without commercial disposal pathways for much or all of the past several decades. These challenges were particularly acute from 2008 to 2012, when commercial LLRW generators in 36 states were entirely without commercial sealed source disposal access. The remaining states had commercial access at their respective regional Compact disposal facilities. However, in three of these states (New Jersey, South Carolina, and Connecticut), sealed source generators in three additional states were able to dispose of sealed sources only up to 10 Ci (0.37 TBq) –just one third of the effective Class C limit for risk-significant sources such as Cs-137 and Ir-192.[3] During this period, thousands of disused and unwanted sealed sources were relegated to storage at the hospitals, universities, and industrial locations at which they were used or manufactured. Because of the potential for loss, theft, or abandonment, the increased number of sources in storage became a significant concern to Federal, State, and private sector stakeholders. [4]

In April 2012, Waste Control Specialists (WCS) began commercial disposal operations at a newly licensed disposal facility in Andrews County, Texas, becoming the first LLRW Compact facility to become operational since Congress created the LLRW Compact system in 1980.[4] The

[3] Class A LLRW generators located in states without access to a Compact facility maintained access to the Energy*Solutions* LLRW disposal site near Clive, Utah. However, the Clive facility was not licensed to accept sealed sources for disposal.

[4] Low-Level Waste Policy Act of 1980 (Pub. L. No. 96-573 (subsequently amended by the Low-Level Radioactive Waste Policy Amendments Act, 42 U.S.C. §§ 2021b-2021j)).

WCS site license allows the facility to accept Class A, B, and C LLRW, including sealed sources, up to the limits established in the NRC's *Final Branch Technical Position on Concentration Averaging and Encapsulation* (1995 CA BTP).[5] [6] While the purpose of the site is to serve the LLRW disposal needs of the states with membership in the Texas Low-Level Radioactive Waste Compact (Texas Compact), currently Texas and Vermont, its governing legislation also allows the facility to accept domestic waste from States without membership in the Compact, or 'non-party states.'[6] Non-party waste generators must obtain approval from the Texas Low-Level Radioactive Waste Compact Commission (Texas Commission) prior to transport of each LLRW shipment, and pay a 20% surcharge on the cost of the disposal.[7]

The Texas Commission from the outset has recognized the importance of disused sealed source disposal for the protection of National security, public health, and safety. All applicants for non-party disposal capacity at the site must indicate on the application whether or not they are disposing of sealed sources, and whether or not they qualify as small generators.[8] Prior to the initiation of operations, the Commission adopted administrative procedures to accommodate disused sealed sources from small generators through a "set-aside" allocation of 2,000 Ci (74 TBq) and 2,000 ft^3 (609 m^3) of capacity for disposal within the annual non-party volume and curie limits set by Texas legislation.[9] These administrative requirements help to ensure that the hospitals, universities, and industrial licensees which generate the vast majority of disused sealed sources have an opportunity to dispose of their sealed source waste.

Despite these measures, commercial LLRW generators in the U.S. have not disposed of their disused and unwanted sources at the Texas facility as quickly as many had expected.. A registry maintained by the NNSA/Offsite Source Recovery Project (OSRP), administered by Los Alamos National Laboratory, currently includes over 30,000 sealed sources which meet current commercial LLRW disposal facility waste acceptance criteria. The OSRP registry is entirely voluntary and likely includes only a fraction of the total number of such sources nationwide. RS estimates that in the three years since commercial disposal operations began at the LLRW disposal facility in Andrews County Texas, LLRW generators from the 36 States previously without commercial source disposal access have used or reserved capacity amounting to

[5] WCS license amendment 26, issue on August 28, 2014, allows the site to use the revised BTP once released for sealed source disposal.

[6] Texas Senate Bill 1504, signed into law on September 1, 2011.

[7] Maximum prices charged to Texas Compact generators for disposal are set by the Texas Compact Commission. However, Texas legislation stipulates these maximum prices be the *minimum* charged to non-party generators. With this restriction, the disposal prices that WCS charges non-party generators are set by contract between the generator and the facility and are not publicly available.

[8] 31 Texas Administrative Code §675.23 defines a small generator as "a generator of low-level radioactive waste who generates no more than 100 cubic feet of such waste per year, provided that the curie level of such waste is minimal as compared to the Compact Facility's license."

[9] The annual limit for non-party waste disposal is set at 50,000 cubic feet (15,240 cubic meters) and 120,000 Ci (4,440 cubic meters) per year.

approximately 1,400 Ci (51.8 TBq) of sealed source waste for a period extending into 2015.[10]

INCENTIVE AND DISPOSAL STAKEHOLDER ENGAGEMENTS

To support ongoing stakeholder efforts to develop efficient and effective incentives to encourage the safe and secure management and timely disposal of sealed sources, NNSA/RS is engaging both public and private sector partners regarding the factors and challenges most relevant to generators in the changed environment. These stakeholders include radioactive material regulators, sealed source manufacturers and users, LLRW brokers, and other relevant organizations. Although the engagement topics have varied depending on the stakeholders involved, the discussions have sought to capture:

- The current level of awareness among sealed source generators regarding commercial sealed source disposal access, costs, and requirements; the factors most relevant to sealed source generators in their decisions regarding sealed source use and disposition;
- Whether or not there are differences among generator types (medical, industrial, academic) with regard to decisions regarding management of sources, including decisions to store, repurpose, or dispose of those no longer in use;
- Whether or not the lack of commercial sealed source disposal access, particularly from 2008 to 2012, has impacted generator decision-making with regard to disposal of disused and unwanted sources, including the extent to which generators (including management and technical staff) have reduced the processes or capabilities necessary for efficient and effective sealed source disposition decisions;
- The perceived costs, if any, of indefinite storage of sealed sources, including the potential financial impact of lost, stolen, or mishandled sources (including those related to incident management reimbursement or other third-party liabilities);
- Whether or not there are differences among generator types –or among various roles within generator organizations, including management and technical staff—with regard to knowledge and/or consideration of costs related to the potential financial impact of lost, stolen, or mishandled sources, and the extent to which these costs are considered by generators in their decisions to use, store, or dispose of sources; and,
- The ways in which governmental and non-governmental stakeholders, including NNSA/RS, can more effectively encourage the timely disposition of disused and unwanted sources.

Because of the sensitive nature of many of the topics involved, many stakeholders have historically been reluctant to widely share~~l~~ their motivations for taking (or not taking) actions

[10] This total includes hundreds of curies of capacity used or reserved for the disposal of Class B/C sources under the Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) program, which were supported by the 50% cost-share amount applied under a pilot effort to dispose of sealed sources at the Clive, Utah facility under a license variance.

with regard to sealed source management. In order to allow for open dialogue and communication during engagements, RS is developing an aggregate assessment of the motivation and incentive factors described by stakeholders, without specific attribution. This approach will allow RS to share the assessment with its partners –both those engaged during product development, as well as those currently considering both regulatory and non-regulatory efforts to address the sealed source disposal challenge.

RS assessments to date suggest that a wide range of factors likely contributes to generator decisions regarding the use and disposition of disused and unwanted sources in storage:

- There are few regulatory incentives to encourage generators to dispose of their sources sooner rather than later. However, there is significant interest and varied concerns regarding the way in which such mechanisms may be structured or implemented – particularly given the historical uncertainties regarding the costs related to eventual source disposal, as well as current disused source transportation challenges (including both cost and availability);
- After several years without sealed source disposal facility access, sealed source generators face some challenges in obtaining the technical or administrative expertise and/or organizational processes necessary for packaging, transportation, and disposal. However, these are not generally the most relevant factors impacting sealed source management and disposal decisions;
- Generators have limited information regarding the potential for source reuse or repurposing, and thus the remaining value, if any, of disused and unwanted sealed sources in storage. This uncertainty makes indefinite storage more likely as sources are retained pending more information regarding their potential value;
- Perceptions regarding the present and future costs and benefits of onsite storage relative to disposal vary significantly, but are not based on developed information or thorough investigation. In particular, there are only general and undefined perceptions of the financial risks and potential liability should a disused source in storage be misused or mishandled. Generators often assume that disposal costs will remain constant or even decrease.

Although the RS engagements are still underway, the information provided thus far suggests the factors discussed above are likely most relevant to generator decision-making with regard to sealed source management and disposal. These factors, in turn, may indicate the types of incentives most helpful in ongoing efforts to encourage timely disposal of disused and unwanted sources. Table 1 provides a simplified representation of generator decision-making in this context. It highlights some of the incentives –costs and benefits—that likely impact whether licensees store, dispose, or otherwise disposition sealed sources in their possession. In essence, a licensee must determine whether or not a source or device has any remaining economic value,

either through further use or through sale to another entity for reuse or repurposing.[11] In order to make this determination, the licensee must assess both the costs and benefits of each course of action.

TABLE 1. GENERATOR DECISION-MAKING – ACTIONS AND INCENTIVES

Licensee Action	Costs[a]	Benefits[a]	Required Information
Short-term storage pending expected further use	▪ Maintenance costs, if any ▪ Regulatory and/or administrative costs, if any ▪ Information identification, collection, and assessment	▪ Operational efficiency if the service/application is needed	▪ Service demand expectations ▪ Source/device service life remaining
Source/device resale or transfer for reuse or repurposing	▪ Time and administrative costs ▪ Transportation and packaging costs, if any ▪ Information identification, collection, and assessment	▪ Economic value of the source or device ▪ Regulatory and/or administrative cost avoidance, if any	▪ Cost/benefit information ▪ Market demand for source/device –including recycle/repurposing ▪ Regulatory/administrative requirements of transfer
Source disposal	▪ Transportation, packaging, and disposal facility costs[b] ▪ Time and administrative costs ▪ Information identification, collection, and assessment	▪ Regulatory cost avoidance, if any	▪ LLRW disposal facility access and waste acceptance criteria ▪ Logistical requirements
None (i.e., indefinite storage)	▪ Regulatory and/or administrative costs, if any	▪ Potential future use value ▪ Potential future transfer value	▪ None

[a] Cost and benefit values in this context are typically understood in monetary terms. However, even when such values are attainable, probability adjustments may be necessary but less transparent.
[b] When commercial disposal is unavailable, sources may be registered for disposal with OSRP.

It is important to note in the table that three of the four courses of action available –short-term storage, source reuse/repurposing, and source disposal—necessarily entail the cost of identifying, collecting, and assessing the appropriate information for a decision to be made. Information-related costs therefore may be a particularly salient variable in the process.

[11] Source 'reuse' or 'recycle' generally refers to transfer of the source to a second licensee for use in the same application. Source 'repurposing' most often refers to transfer of the source to a second licensee for use of the source material in an application different from the original.

INCENTIVE DEVELOPMENT AND IMPLEMENTATION

In 2005, Congress established the Radiation Source Protection and Security Task Force (Task Force) to "evaluate, and provide recommendations relating to, the security of radiation sources in the United States from potential terrorist threats, including acts of sabotage, theft, or diversion for use of a radiation source in a radiological dispersal device."[12] It is required to report every four years to the President and Congress. Of the 25 recommendations made by the Task Force in 2006 and 2010, 18 have been implemented with progress toward seven others still ongoing. Since its initial report in 2006, the Task Force has considered challenges related to the end-of-life management of sealed source, including disposal, to be among its highest priorities. [7, 8]

While the 2014 Report of the Task Force lauds the significant progress in LLRW disposal access since 2010, it also recognizes that challenges remain. To address those challenges, the Task Force made a new recommendation to encourage timely disposal of disused sources and identified additional initiatives that stakeholders can take to improve sealed source management and disposal. With commercial disposal options now widely available for sources previously without disposal access, "a significant remaining challenge is to encourage generators to dispose of these sources in a timely fashion."[13] The Task Force further notes that "[c]urrent NRC regulations provide only limited incentive for LLRW generators to dispose quickly of sealed source waste. . . . Without greater incentives, licensees that use sealed sources may delay these efforts."[14] The Low-Level Waste Forum (LLWF), a stakeholder organization comprised primarily of State regulators and State LLRW Compact officials, came to a similar conclusion in a 2014 published report. Its *Report of the Disused Source Working Group: A Study of the Management and Disposition of Sealed Source from a National Security Perspective* notes that the "current system provides no incentives to remove sources from storage for reuse, recycling or disposal, nor does it provide any disincentives to storage."[15]

In its report, the Task Force addresses both regulatory and non-regulatory incentives with the potential to enhance licensee decisions regarding the use, management, and disposal of sealed sources. Regulatory measures could include new or strengthened requirements, new or revised regulatory or inspection guidance, or information sharing by regulators and licensees. Non-regulatory measures, similarly aimed, could focus on information-sharing with regard to both opportunities for cost effective source disposition, as well as potential costs to a licensee if a source in storage is lost or stolen.

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[12] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 1. Established in Section 651(d) of the Energy Policy Act of 2005 (Public Law 109-58), the Task Force is comprised of 14 Federal agencies and the Organization of Agreement States, with non-voting membership accorded also to the Organization of Agreement States. Its reports are available at http://www.nrc.gov/security/byproduct/task-force.html.

[13] NRC, *2014 Radiation Source Protection and Security Task Force Report*, pp. 32-33.

[14] *Ibid*.

[15] Low Level Waste Forum, *Report of the Disused Source Working Group: A Study of the Management and Disposition of Sealed Source from a National Security Perspective*, p. 18.

REGULATORY INCENTIVES

The potential regulatory measures discussed in the Task Force report include those to encourage licensees to identify and assess sealed sources in storage and to disposition disused sources in a timely fashion (i.e., transfer the source for reuse or repurposing, or arrange for proper source disposal). As described in the 2014 Task Force Report, while implementation of each measure alone may be helpful, a combination of such measures taken together could have an impact greater than the sum of its parts on sealed source management and timely disposal.

Use-Status Identification and Storage Time Limits

Unless asked to do so, sealed source licensees may not consider the use-status of their sources, i.e., whether or not a sealed source in storage is disused and unwanted. As a result, storage of sources is a low-cost default relative to considerations of further use or source disposition. In recognition of this challenge, the NRC recently released Regulatory Issue Summary (RIS) 2014-04, "National Source Tracking System Long-Term Storage Indicator," to encourage National Source Tracking Systems (NSTS) users to identify sources in long-term storage and the reasons why they are there. [9] The NRC RIS describes the value that use-status identification may have for both licensees and regulators. For licensees, for example:

> [S]uch a practice will encourage increased awareness of, and attention to, effective disused sealed source management, which may include financial and logistical planning for disposal, including related transportation costs and challenges. For sealed sources without a commercial disposal pathway, planning may involve coordination with source recyclers (including manufacturers), or Federal programs which facilitate the recovery and disposition of disused sources. This type of attention and planning will not only facilitate timelier sealed source disposition, but also increase licensee awareness of the national security and public health and safety concerns related to keeping disused and unwanted sealed sources in storage for longer than necessary.[16]

For regulators, use-status information could provide increased transparency on the number, type, and location of disused and unwanted sources they license. In some cases, the information may also indicate to regulators which licensees are likely to have transportation and/or disposal access challenges related to their disused and unwanted sources. In general, for both regulators and licensees, "this type of information sharing will improve the quality and efficiency of sealed source management and disposition, which, in turn, will benefit national security, public health, and safety."[17]

While the NRC RIS is a helpful development, the NSTS is a system which administratively tracks only IAEA Category 1 and 2 sealed sources. Only a fraction of the sources licensed in the U.S. are therefore included, with a significant number of these exceeding the radioactivity levels

[16] NRC, Regulatory Issue Summary 2014-04, "National Source Tracking System Long-Term Storage Indicator," p. 2.

[17] *Ibid*.

accepted at currently operational commercial LLRW disposal facilities. For this reason, State regulators and other stakeholders have proposed measures to encourage or require generators to provide use-status information for a broader range of sources. For example, one of the recommendations in the LLWF report on disused source management and disposal is for the NRC and Agreement States to "incorporate procedures in their current inspection programs to review the status of Category 1 through 3 sources in storage—including consideration of the length of, reason for, and location of storage." Although States that choose to further address this issue will likely vary in the most efficient and effective way to do so, there is increasing recognition that encouraging identification and sharing of use-status information will improve sealed source life-cycle management, thereby enhancing National security, public health, and safety.

While use-status identification and information sharing alone may yield the positive benefits identified in the NRC RIS, it would also support another option for improving the way in which generators handle disused and unwanted sources: storage time limits. Storage time limit requirements could only be effective once a licensee has identified whether or not a source in storage has further value, either to it, or to another licensee through resale or transfer. Without storage time limits, indefinite storage of sources may result simply because it is a low-cost and open-ended solution for licensees. As the Task Force noted, "disused sealed sources require only limited storage space or in-storage maintenance. In addition, commercial disposal of sealed source waste is costly: both time and funding are required for packaging, transportation, and disposal at a licensed commercial LLRW disposal facility."[18] Without a limit on the time that a source may remain in storage, a generator may have no incentive to consider whether or not it is disused, or how it can most effectively be dispositioned.

New rules under consideration in Texas demonstrate how use-status identification requirements and storage time limits may work in tandem. The Texas State Department of Health Services is currently considering draft revisions to the Texas Administrative Code to prohibit sealed source licensees from holding "radioactive waste, or sources or devices that are not in use, for longer than 2 years following the last principal activity use" unless the regulator approves a plan for future use prior to the two-year time limit. Taken together these stipulations require generators to be aware of and address the use and disposition possibilities for of all of their sources in inventory.

In addition to explicit time limits for sealed sources in storage, there are potential regulatory approaches that could achieve a similar end through different means. For example, sealed source licensees in the State of Oregon are charged an annual fee for certain sealed sources in their possession. These fee amounts vary according to the type of device and license, the latter of which is tied to its level of radioactivity. Annual fee amounts range from several hundred dollars for lower-activity, generally licensed material to several thousand dollars for higher-activity,

[18] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 32

specifically licensed devices.[19] Because these fees are assessed on an annual basis, licensees have an incentive each year to make a considered determination regarding plans for further use of sources in inventory, and to explore resale and disposal options if storage of the source pending further use is not cost-effective.

Financial Assurance

Financial assurance requirements are generally used by radioactive material regulators to ensure that licensees above a threshold license possession limit are able to cover the cost of decommissioning their facilities upon closure. In such instances, licensees are required to guarantee through an approved financial instrument (such as surety bond or certificate of deposit) or financial arrangement (such as insurance coverage or other third-party guarantee) that the funds will be available. The arrangements are intended to address situations in which some or all of the cost of expensive decommissioning might otherwise fall on the taxpayer, such as cases in which a facility which manufacturers radioactive materials enters bankruptcy or is otherwise unable to meet its decommissioning obligations.

While decommissioning fund requirements serve an important purpose for the protection of public health and safety in certain situations, they are not intended to encourage or facilitate sealed source disposition within the productive lifetime of a licensed facility. Because they are aimed at particular types of licensees, the radioactivity threshold amounts which trigger the requirements are far higher than those which would generally apply to sealed source users. The NRC, for example, requires financial assurance only for licensees exceeding a 100,000 Ci (3700 TBq) possession limit for Cs-137 and a 10,000 Ci (370 TBq) limit for Co-60. In contrast, the Category 2 threshold for these two radionuclides is 27 Ci (1 TBq) and 8 Ci (0.3 TBq) respectively. There is no NRC financial assurance threshold at all for Ir-192, another of the most commonly used and high-risk radionuclides. In addition, this type of financial assurance is tied to radioactivity possession limits stipulated in materials licenses, but is not directly related to the actual material quantity a licensee may have in its possession at any given time. As the Task Force notes, "there is little direct correlation between NRC financial assurance requirements and the Category 1 and 2 sealed sources of greatest concern from a National security standpoint."[20] As a result of these features, the current financial assurance requirements do not encourage licensee consideration of the use-status of particular sources in storage, nor do they impact decisions on when to disposition disused and unwanted sealed sources prior to facility closure.

In the development of financial assurances as an incentive for improved sealed source life-cycle management (including timely disposal of disused and unwanted sources), differences from decommissioning requirements should be explored. First, financial assurance amounts could be tied to specific sealed sources or devices in licensee inventories, and not simply to the possession

[19] State of Oregon Health Authority, Public Health Division, "Oregon Administrative Rules/Fees," available at http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_333/333_103.html.

[20] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 32.

limits stipulated in the license. Similar to the fees charged by the State of Oregon, financial assurance amounts could be tiered in a way that generally reflects the level of risk associated with a source or device. The financial assurance mechanism could also allow for a variable increase and decrease in guaranteed funds as sealed sources are either added to or removed from licensees' inventories. Responsive mechanisms would ensure that licensees realize within a reasonable timeframe the benefit of decisions to disposition a disused and unwanted source through transfer or disposal.

In addition, financial assurance amounts should consider the range of costs related to source disposition, including transportation, processing, and final disposal at a licensed facility. If the cost of source disposition exceeds the funds returned to the generator as a result, the incentive impact of the requirement could be diminished or eliminated entirely. Such costs vary depending on wide range of factors, such as the type, radioactivity, and condition of the source or device, packaging and transportation requirements, and the cost of final disposal at an appropriate facility. Since the WCS commercial LLRW facility in Texas became operational, it has added significantly to the information available for making such determinations; although, it may take additional time for regulators to determine the most effective financial assurance amounts for the types of sources and devices typically under their purview.

In 2014, with commercial disposal access increased (and potentially increasing), the Task Force formally recommended that the NRC address the issue of financial planning for disposition/disposal costs:

> **2014 Recommendation 2:** The Task Force recommends that the NRC evaluate the need for sealed source licensees to address the eventual disposition/disposal costs of Category 1 and 2 quantities of radioactive sources through source disposition/disposal financial planning or other mechanisms. Disposition costs should include the cost of packaging, transport, and disposal (when available) of these sources.

The Task Force also noted that "the rulemaking process should carefully consider the compatibility category assigned to the rule, recognizing the importance of Agreement States maintaining flexibility in developing a compatible requirement that meets or exceeds the NRC standard."[21] This flexibility would allow States to broaden financial assurance requirements to address Category 1 to 3 sources as recommended in the 2014 report by the LLWF, or include other provisions to make the rules most effective for State and its licensees.[22]

[21] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 35. The NRC's compatibility category designation determines the extent to which Agreement States must develop a corresponding rule and to what extent the State rule may vary from the NRC's formulation.

[22] Low Level Waste Forum, *Report of the Disused Source Working Group: A Study of the Management and Disposition of Sealed Source from a National Security Perspective*, p. 17.

NON-REGULATORY INCENTIVES

In addition to the regulatory mechanisms under stakeholder consideration, non-regulatory measures could provide incentives for generators to disposition disused and unwanted sources sooner rather than later. These could include cost-share and other support to encourage timely action, such as that provided by the CRCPD/SCATR program. However, given the recent and ongoing changes in sealed source disposal landscape, as well as current efforts to consider regulatory incentives, information-sharing may be particularly important as a way to encourage to assess and disposition their sources in a timely manner.

Information Sharing and Incentives

The terrorist attacks of September 11, 2001 significantly increased the National security, public health, and safety concerns related to sealed sources. In the years that followed, Federal, State, and non-governmental policies and practices with regard to commercial sealed source management and disposal evolved accordingly, including both regulatory and non-regulatory measures to facilitate the safe and secure use and disposition of commercially licensed sealed sources. The challenges and successes with regard to commercial disposal access during this period have also been extraordinary. In addition to commercial disposal facility access changes before, during and after the 2008 to 2012 period, the NRC has nearly completed revisions to the 1995 BTP, which has determined the effective radioactivity limits for commercial sealed source disposal for nearly two decades. The revised guidance is expected to enable a significant increase in the number and type of commercially disposable sealed sources, including those most important from a National security, public health, and safety perspective. For Cs-137, for example, the generic Class C limit is expected to increase from 30 Ci (0.37 TBq) to 130 Ci (4.81 TBq), with the potential for disposal up to the Class C limit of 957 Ci (35.4 TBq) with use of "alternative approaches" described in the document.[23] [10]

Given the type and extent of these changes, information-sharing has become an important way in which stakeholders can encourage sealed source generators to assess and disposition sealed sources in storage. As demonstrated in Table 1, each of the generic options for sealed source disposition, except for storage, entail information collection and assessment, effectively increasing the costs related to those options. If the relevant information is readily accessible, the costs related to the options will decrease accordingly. In this regard, information-sharing becomes a way to incentivize generators to consider the use-status of their sources in storage, and to disposition their sources appropriately. The types of information relevant in this regard are likely many, but a few of the most important include information relating to:

- Sealed source disposal costs and requirements at WCS, including disposal costs for generators in States without membership in the Texas Compact;
- The types of sources and devices most in demand for reuse or repurposing, and the

[23] The 10 CFR 61.55 Class C limit is 4,600 Ci/m^3 or 170.2 TBq. Under the typical assumption of disposal in a 55-gallon drum (0.2082 m^3), the result is a concentration averaged activity of 957 Ci or 35.4 TBq.

associated costs and requirements of transfer to another licensed user;
- The types of sources and devices likely to fall within the increased generic disposal limits and waste acceptance criteria at the various commercial LLRW disposal facilities as result of implementation of the revised BTP, once final.
- Use of the "alternative approaches" to disposal included in the revised BTP, once final, including the types of sources and devices likely to meet facility waste acceptance criteria;
- The types of generators and sources eligible for disposal support through CRCPD and OSRP following implementation of the revised BTP, once final, as well as expectations regarding cost-share amounts, when relevant;

One further area in which information-sharing could impact the generator assessment of the costs and benefits of life-cycle management options is the potential liabilities faced by licensees if a source in their possession is lost or stolen, resulting in off-site damages. There is general agreement that the financial impact of such an event could be profound due to event recovery costs, including decontamination, displaced business costs, and "perception-based costs" related to public reaction to the radiological nature of the event.[24] However, the way in which these costs would be allocated among stakeholders, including the source licensee, remains unclear. For example, if a standard of "strict liability" were applied by the courts, a licensee could be held responsible for damages regardless of the licensee's compliance with the applicable source security and protection regulations. Furthermore, strict liability, one commenter has pointed out, is the standard that courts in the United States have tended to use for users of ultrahazardous materials. [11]

The liability risk to licensees is clearly a relevant cost factor with regard to the storage or disposition of sources. However, further information development and sharing is necessary for it to appropriately impact licensee decision-making. The Task Force noted that "[f]or licensees to make informed decisions on the management and use of sealed sources, information on the potential liabilities must be as clear as possible. Increased clarity and communication on the liabilities that sealed source licensees may face as the result of a lost or stolen source could also function as an incentive to licensees for timely disused sealed source disposal."[25] Liability information-sharing has also been identified as a key topic by the IAEA for improving the life-cycle management of sources. [5, 12]

CONCLUSION

As policymakers and non-government stakeholders consider ways to encourage generators to address sealed sources in storage, an accurate understanding of generator decision-making is essential. Development and implementation of both regulatory and non-regulatory mechanisms

[24] According to a recent study by Miles Pomper, Senior Research Associate at the James Martin Center for Nonproliferation Studies, "Government studies indicate that an attack in downtown Manhattan or London would incur event recovery costs alone estimated at $25 billion per square kilometer." [10]

[25] NRC, *2014 Radiation Source Protection and Security Task Force Report*, p. 37.

to encourage disused source disposition will be most efficient and effective if the accurately reflect the costs and benefits as perceived by generators. The stakeholder engagements undertaken by NNSA/RS provide a preliminary indication regarding the ways in which the regulatory and non-regulatory incentives under consideration can be most effective.

REFERENCES

[1] IAEA, *Strengthening Control Over Radioactive Sources in Authorized Use and Regaining Control Over Orphan Sources*, IAEA-TECDOC-1388, Vienna, 2004.

[2] IAEA, *Information, Resources, and Advice for Key Groups About Preventing the Loss of Control Over Sealed Radioactive Sources*, IAEA/PI/A.98 /13-32051, 2013.

[3] Low-Level Radioactive Waste Forum, *Report of the Disused Sources Working Group: A Study of the Management and Disposition of Sealed Sources from a National Security Perspective*, 2014.

[4] Department of Homeland Security, Removal and Disposition of Disused Sources Focus Group, *Sealed Source Disposal and National Security: Problem Statement and Solution Set*, Washington, DC, 2009; Available at http://osrp.lanl.gov/docs.shtml.

[5] NRC, *The 2014 Radiation Source Protection and Security Task Force Report*, Washington DC, August 14, 2014.

[6] NRC, *Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position*, Washington, DC, 1995.

[7] NRC, 2006 *Radiation Source Security and Protection Task Force Report*, Washington DC, 2006

[8] NRC, 2010 *Radiation Source Security and Protection Task Force Report*, Washington DC, 2010.

[9] NRC, *National Source Tracking System Long-Term Storage Indicator*, Regulatory Issue Summary, 2014-04 ML14100A15.2

[10] NRC, *Draft Branch Technical Position on Concentration Averaging and Encapsulation, Revision 1*, May 2012, available at http://pbadupws.nrc.gov/docs/ML1211/ML121170418.pdf.

[11] Miles A. Pomper, Mind the Gap: The Role of Liability and Insurance Regimes in Strengthening Radiological Security, James Martin Center for Nonproliferation Studies, August 2014.

[12] IAEA, “Findings of the President of the Conference,” International Conference on the Safety and Security of Radioactive Sources: Maintaining Continuous Control of Sources Throughout Their Life Cycle, Abu Dhabi, Oct 27-31, 2013.