# Commercial Sealed Source Disposal in the U.S.: Progress, Challenges, and Areas for Further Assessment – 14302

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## ABSTRACT

Ensuring commercial radioactive sealed source disposal access in the U.S. has been a significant challenge. From 2008 to 2012, commercial sealed source generators in 36 U.S. states were unable to dispose of disused and unwanted sources. Accumulation of these sources in storage became a significant concern from a National security, public health, and safety perspective. In 2012, additional commercial disposal options became available, resulting in the disposal of thousands of commercial Class A, B, and C sources previously relegated to indefinite storage. Despite these successes, challenges remain. it appears from limited data that sealed source generators are not disposing of accumulated sealed sources as quickly as many had expected. Low rates of disposal present a policy challenge for those in both industry and government charged with the life-cycle management of sealed sources. Furthermore, there remains no commercial disposal access for many commonly used sources with activity levels exceeding those eligible for disposal at currently licensed LLRW facilities. Progress in addressing these challenges may include the expected revisions to the NRC's "Final Branch Technical Position on Concentration Averaging and Encapsulation," as well as implementation of financial assurance mechanisms for risk-significant sealed sources.

## INTRODUCTION

Radioactive sealed sources are used thousands of times per day in the U.S. most notably in medicine, agriculture, and industry. Medical professionals use Co-60 sources to treat cancer patients, and irradiators containing Cs-137 and Co-60 are commonly used to sterilize blood and surgical instruments. Cs-137 and Co-60 are similarly used to irradiate bulk quantities of food to make it safe for consumption. In industry, portable devices containing Am-241 are widely used for petroleum exploration, while Ir-192 devices are used in applications that depend upon precise materials measurement and structural analysis. The radioactivity of these sources ranges from microcuries (µCi) to thousands of curies (Ci) for the largest sources used in industry and medicine. However, thousands of sources commonly used are a concern from a National security, public health, and safety perspective.

## MANAGING SEALED SOURCE RISKS AND BENEFITS

Over 55,000 sealed sources used commercially in the U.S. exceed IAEA Category 1 and 2 thresholds, the highest two of five categories designated in its "relative ranking of radioactive sources in terms of their potential to cause immediate harmful health effects if the source is not safely managed or securely protected." [1] In 2004, the IAEA concluded that Category 1, 2, and 3 sealed sources "pose a significant risk to individuals, society,

and the environment," [2] and that "appropriate security measures should be applied to reduce the likelihood of malicious acts involving these sources." [3][a]

Despite these benefits, sealed source use poses National security, public health, and safety risks which must be managed. If used maliciously in a radiological dispersal device (RDD or "dirty bomb"), certain types of radioactive material, including commonly used Cs-137, Co-60, Am-241, and Ir-192 sources, could cause significant and costly damage.[b] Individuals exposed to harmful radiation could suffer severe health consequences or death as a result, and dispersed radioactivity could render large urban areas uninhabitable for months or longer. The costs associated with evacuation and remediation of an urban area after such incident could be hundreds of billions to several trillions of dollars, depending on the location, the amount and type of radioactive material deployed, and remediation challenges and standards.[c] These studies also suggest that the social and psychological impact of such an event could be profound and far-reaching. [5, 6, 7, 8, 9,10, 11]

The service lives of the most common commercially used sealed sources range from 10 to 30 years, after which they generally become disused and unwanted.[d] However, many of these sources remain highly radioactive and of concern from a National security, public health, and safety perspective. Thousands of sources become disused and unwanted every year in the United States and must remain in storage pending final disposition. While secure storage is a temporary measure, the longer sources remain disused or unwanted, the chances increase that they will become unsecured or abandoned, and thus more vulnerable to misuse. [12, 13, 14, 15, 16] Domestic and international experts agree that the lack of disposal availability for unwanted sealed radiological sources makes them "more vulnerable to abandonment, misplacement, and theft that would pose a safety and security risk." [13, 14] A 2005 GAO assessment agreed with the IAEA that "the most vulnerable sources to abandonment, misplacement, and theft are those that are unwanted and in storage."[13] GAO concurred with the IAEA that "[h]istory has shown that many accidents involving orphan sources come about because sources that are no longer in use are eventually forgotten, with subsequent loss of control years later. To this

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[a] These security measures are described in the 2004 IAEA Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2004, [2] available at http://www-ns.iaea.org/tech-areas/radiation-safety/code-of-conduct.htm, as well as in the 2009 *IAEA Nuclear Security Series No. 11, Implementing Guide, Security of Radioactive Sources*, STI/PUB/1387 http://www-pub.iaea.org/MTCD/publications/PDF/Pub1387_web.pdf. [3]

[b] A National Research Council of the National Academies report requested by Congress in 2005 to study replacement technologies for risk-significant sources concluded these four radionuclides account for 99% of the risk-significant sealed sources in commercial use. [4]

[c] A 2005 PNNL study assessed the economic impact from an RDD containing a Cs-137 sealed source of lower activity than that employed in large commercial irradiation devices. The study concluded that 10,000Ci of Cs-137 effectively employed in New York City could cost upwards of 4 trillion dollars depending primarily upon which of the various cleanup standards in current regulations is adopted following the event. [4]

[d] The IAEA defines a "disused" sealed sources as "a radioactive source that is no longer used, and is not intended to be used, for the practice for which an authorization has been granted." [2] While some disused sealed sources may have the potential for recycle (i.e., sold or transferred to a new licensee for continued use), the vast majority are either decayed below the point of utility or for other reasons are not amenable to further use.

end, it is beneficial from both a safety and security viewpoint for all disused sources to be identified and to undergo proper disposition." [13, 14]

The terrorist attacks of September 11, 2001 significantly increased concerns with regard to deployment of an RDD. Federal, State, and non-governmental policies and practices with regard to commercial sealed source management and disposal have changed according. Long-standing challenges are continually addressed with a new sense of urgency, reflecting not only the risks that radioactive sealed sources can pose if used maliciously, but also the societal benefits of sealed source use. Of the many security-related topics addressed by both the nuclear and radiological materials industry and government since 2001, facilitating commercial disposal of disused and unwanted sources has been widely identified as a particularly important and difficult challenge. [12, 13, 14, 15]

## U.S. COMMERCIAL SEALED SOURCE DISPOSAL: HISTORY AND POLICY

For the purposes of disposal, all LLRW generated in the U.S. is either "commercial" or "federal", depending on the entity that owns the waste when it is generated. Commercial LLRW is generally defined as low-level waste resulting from activities licensed by the U.S. Nuclear Regulatory Commission (NRC) or an NRC Agreement State. "Federal" LLRW is comprised primarily of low-level waste owned or generated by DOE, as well as LLRW resulting from Naval reactor decommissioning and U.S. atomic weapons production. Commercial LLRW in the U.S. is classified according to NRC regulations as Class A, B, C, or Greater-than-Class C (GTCC), depending on the potential radiation exposure to an inadvertent intruder who encounters the waste after the period of institutional control of the disposal facility has ended.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) [PL 99-240, as amended], gave the Federal government responsibility for the disposal of GTCC LLRW and each State responsibility for the disposal of Class A, B, and C LLRW generated within the State (except for certain waste generated by the Federal government). The LLRWPAA authorized the States to enter into compacts for the establishment and operation of regional LLRW disposal facilities, and authorized States and Compacts to impose certain restrictions on disposal of LLRW generated outside the Compact region. Pursuant to the LLRWPAA, DOE is responsible for disposal of Greater-than-Class C LLRW generated by NRC and Agreement State licensees.

### Sealed Source Disposal Access and Federal Interagency Efforts, 1985 to 2012

By 1991, 7 out of 10 of the regional compacts had met the first three of the five milestones for the development of a new commercial LLRW disposal facility by filing a complete license application for a new facility or receiving a gubernatorial certification that the state or regional compact would provide for the disposal of its waste. [17] However, in June 1992, the U.S. Supreme Court struck down an additional incentive provided in the LLRWPAA, due to take effect on in January 1, 1993. The LLRWPAA's so-called "take-title" provision would have required states to take ownership and possession of LLRW, including sealed sources, if it failed to provide a LLRW disposal option by that

date. [17] By 2000, none of the 10 regional compacts remained on track to develop a new disposal facility.

In 2001, after decades of accepting waste from LLRW generators across the Nation, South Carolina exercised its right under the LLRWPAA to restrict access to the commercial LLRW disposal facility near Barnwell, South Carolina ("Barnwell"). The State legislation set July 1, 2008 as the date after which access to Barnwell would be restricted to the three member states of the Atlantic Interstate Compact, Connecticut, New Jersey, and South Carolina. LLRW Generators within these states would maintain the ability to dispose of many common sealed sources, including Cs-137, up to 10Ci at the Barnwell facility. Generators in 11 additional States would maintain access to the commercial LLRW disposal facility near Richland, Washington ("Richland"), which accepted these sources up to 30Ci.[e] Licensees in the remaining 36 states, however, would have no commercial disposal options for their disused and unwanted sealed sources, relegating them instead to indefinite storage.[f]

As the Barnwell restriction date approached, concern regarding the National security, public health, and safety impact of the potential accumulation of sealed sources at generator sites increased significantly. In 2004, the GAO assessed radioactive waste management challenges, noting that "the perceived security risks of stored LLRW have heightened since 2001 because of the potential to use some of this material in radioactive dispersal devices, sometimes known as 'dirty bombs.'"[15] In 2005, the GAO similarly warned that while "NRC does not place time limits on the storage of radioactive materials as long as they are safe and secure, greater quantities and longer periods of storage, particularly of unwanted sealed radiological sources, will likely increase safety and security risks." [13] In 2005, Congress established a Federal interagency task force on radiation source protection and security ("RSPS 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 use of a radiation source in a radiological dispersal device." The RSPS Task Force mandate included an assessment of commercial sealed source disposal, including the issues and possible solutions identified in the 2004 and 2005 GAO reports.[g]

The creation of the RSPS Task Force and the Barnwell restrictions ignited Federal

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[e] The U.S. Ecology site in Richland, Washington ("Richland") accepted sealed sources from the 11 members of the Northwest Interstate Compact ("Northwest Compact") (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington, and Wyoming), and the Rocky Mountain Low-Level Radioactive Waste Compact ("Rocky Mountain Compact"), comprised of Colorado, Nevada, and New Mexico. A third LLRW disposal facility, operated by Energy*Solutions* near Clive, Utah ("Clive"), accepted Class A non-sealed source LLRW from all 50 states for disposal. However, its license does not allow it to accept sealed sources of any type for disposal.

[f] A third LLRW disposal facility, operated by EnergySolutions near Clive, Utah ("Clive"), accepted Class A non-sealed source LLRW from all 50 states for disposal. However, its license does not allow it to accept sealed sources of any type for disposal.

[g] Established by the EPAct , the Task Force is comprised of 14 Federal agencies and two state organizations and Chaired by the NRC. It is required under the 2005 legislation to report every four years to the President and Congress on ways to improve the security of domestic radioactive sealed sources.

interagency efforts to address the National security, public health, and safety challenges posted by the lack of commercial sealed disposal options. In February of 2009, the Department of Homeland Security (DHS), under the its Critical Infrastructure Protection Advisory Council (CIPAC) framework, established the public-private Removal and Disposition of Disused Sources Focus Group ("Focus Group"). The Focus Group included representatives from the NRC and State regulatory agencies; sealed source and device manufacturers, distributors, and users; sealed storage and disposal operators, LLRW compact members, and other Federal stakeholders such as DOE, EPA, and HHS. The Focus Group published its findings and recommendations in two reports. The 2009 report, *Sealed Source Disposal and National Security: Problem Statement and Solution Set*, developed a consensus definition and description of the National security concerns and policy challenges associated with the lack of commercial disposal options. The June 2010 report, *Sealed Source Disposal and National Security: Recommendations and Messaging Strategy*, identified a potential path forward toward solutions. [18]

In 2010, the Federal interagency the RSPS Task Force, identified the lack of disposal options for disused and unwanted sealed sources as the most pressing problem for sealed source security. Its August 2010 report concluded that "[b]y far the most significant challenge identified is access to disposal for disused radioactive sources," and that "continued coordinated effort is needed to make sure that comprehensive, sustainable disposal pathways for all disused sealed sources are developed in the interest of national security."

## WCS, Clive and Sealed Source Disposal

Despite repeated and costly attempts since the LLRWPA was enacted since 1980, no new commercial LLRW disposal facilities licensed for sealed source disposal had been developed in the U.S. in decades. However, in April 2012, Waste Control Specialists (WCS) initiated commercial LLRW disposal operations at its newly developed facility located in Andrews County, Texas nearly a decade after its selection. The site was selected by the Texas State legislature in 2003, its third attempt to site a LLRW facility since 1987.[h] The primary purpose of the new facility is to serve generators in states with membership in the Texas Compact, currently Texas and Vermont. However, in accordance with the LLRWPAA, Texas legislation, and rules approved by the Texas Low-Level Radioactive Waste Compact Commission ("Texas Commission"), WCS may also accept waste from generators in states that are not members of the Texas Compact. Table 1summarizes commercial sealed source disposal access since the passage of the LLRWPAA in 1985.

[h] A site at Fort Hancock in Teas was selected by the State in 1987, but a State court issued a permanent injunction against the selection in 1991. A Sierra Blanca site was then selected, but a 1992 license application for the site was rejected by State Court in July 1998. In 2003, the Texas legislature designated a second geographic area in Andrews County as acceptable for a new disposal facility. [17]

**Table 1: Commercial Sealed Source Disposal Options: Timeframe and Activity Limits**

| Years | Compact | # of States | Class C Limit* | Disposal Option |
|---|---|---|---|---|
| **Pre-2008** | Northwest and Rocky Mountain Compacts | 11 | 30Ci | Richland |
| | Atlantic Compact | 3 | 10Ci | Barnwell |
| | All Other States/Compacts | 36 | 10Ci | Barnwell |
| **2008 to 2012** | Northwest and Rocky Mountain Compacts | 11 | 30Ci | Richland |
| | Atlantic Compact | 3 | 10Ci | Barnwell |
| | All other States/Compacts | 36 | ***No Disposal Options*** | |
| **2012 to Present** | Northwest and Rocky Mountain Compacts | 11 | 30Ci | Richland |
| | Atlantic Compact | 3 | 10Ci/30 Ci | Barnwell/WCS ** |
| | Texas Compact and all other States/Compacts*** | 36 | 30Ci | WCS |

* The cited Class C limit is for Cs-137 and other commonly used sources with similar radiological characteristics.
** Atlantic Compact generators may dispose of Cs-137 and similar sources up to 10Ci at the Barnwell facility; these generators may dispose of Cs-137 and similar sources between 10Ci and 30Ci at WCS.
*** Certain Class A disused sealed sources were also accepted at Clive in 2013-2014, in accordance with the 2012 Energy*Solutions* license variance for the site.

***Commercial disposal options for sealed sources above 30Ci remain unavailable***

Each shipment of waste from non-member states to WCS must be approved by the Texas Commission prior to transport, including a signed agreement between the generator and the Texas Commission specifying the characteristics of the non-member waste to be disposed. The application and agreement must specify the volume and curies of the waste, and whether or not the waste includes sealed sources. Applicants must also indicate whether or not the waste is from a “small generator,” as defined by the Commission. Current rules allow the WCS facility to accept up to 120,000Ci and 50,000 cubic feet per year from non-member states. WCS waste acceptance criteria (WAC) permit disposal of sealed sources up to the curie limits specified in 30 Texas Administrative Code §336.362(a) for Class C low-level radioactive waste, including the 30Ci upward limit for Cs-137 and similar sources. Non-member access to the WCS facility has made sealed source disposal available to generators in all 36 states which had been without disposal options since the closure of Barnwell to non-Atlantic Compact generators four years earlier.

Also in 2012, the Energy*Solutions* LLRW disposal facility located near Clive, Utah received a one year license variance to dispose of certain Class A sealed sources recovered through the Source Collection and Threat Reduction Program (SCATR) funded through a grant from the DOE National Nuclear Security Administration (NNSA) and administered by the Conference of Radiation Control Program Directors (CRCPD).[i] Application for, and approval of, the license variance was a cooperative effort by Energy*Solutions*, Utah regulators, and NNSA, and was specifically intended to support sealed source security efforts. The one year license variance window opened with the initial SCATR sealed source shipment to Clive in September 2013.

To take advantage of the newly available opportunities for Class A, B, and C sealed source disposal at WCS and Clive, and to address the backlog of disused and unwanted sealed sources in storage, the CRCPD SCATR program offered generators the states without disposal options since 2008 a 50% cost-share for packaging, transportation, and disposal of the Class A sources meeting the Clive WAC. In addition, CRCPD offered these generators the 50% cost-share for packaging, transportation, and disposal at WCS of their Class B and C disused sources. While generators have not participated at the rates that many had hoped, the effort has disposed, or has scheduled for disposal, over 3,000 Class A disused sources at Clive, and 1500 Class B and C sources at WCS. All of these sources were recovered from small generators, such as hospitals and facilities, which are of greatest concern from a National security, public health, and safety perspective.

## LOOKING FORWARD: ENABLING AND ENCOURAGING SEALED SOURCE DISPOSAL

In its 2004 report on orphan and vulnerable sources, the IAEA found that "[l]icensees are discouraged from proper disposal of disused sources by the cost involved, by the bureaucracy of doing so, or by the lack of an available disposal option." [14] Addressing these factors in the U.S. will help to reduce the risk that disused sealed sources in storage will be lost or stolen and misused.

### Enabling Disposal: Revision of the Branch Technical Position on Concentration Averaging

Prior to shipping waste for disposal, commercial LLRW generators must classify waste as Class A, B, C, or GTCC, which requires the radioactivity of the waste to be averaged over its volume. The methods appropriate for these calculations will vary depending upon the physical and radiological characteristics of the waste. The NRC's 1995 "Final Branch Technical Position on Concentration Averaging and Encapsulation" ("1995 BTP") [19] provides guidance to LLRW generators in this determination. To facilitate its use by both generators and commercial disposal facilities, the NRC guidance also provides 'reference' class limits for commonly disposed types of LLRW, including sealed sources.

[i] SCATR provides both technical and cost assistance to generators on a case by case basis to facilitate the removal and disposition of sealed source waste. Information on CRCPD SCATR sealed source recovery and disposal efforts, including Energy*Solutions* Clive license variance, may be found at http://www.crcpd.org/StateServices/SCATR.aspx.

For example, the 1995 reference limit for commonly used Cs-137 sealed sources is 30Ci.

All of the States which currently regulate commercial LLRW disposal facilities (South Carolina, Utah, Washington, and now Texas) require generators to use part or all of the 1995 BTP for waste classification. For some types of waste, these states have simply adopted the reference class limits, and no state currently accepts sealed sources exceeding them. The 1995 BTP has thus effectively established the activity limits for commercially disposed sealed sources. As a result, the activity limits for sealed sources are a fraction of those specified in the NRC waste classification regulations at 10 CFR § 61.55.

In 2007, the NRC staff performed a strategic assessment of the NRC's regulatory program for LLRW. The assessment focused on "significant new and emerging LLW disposal issues" [20], including increased security concerns surrounding sealed sources. The strategic assessment identified an update of the 1995 BTP as a priority item, noting that such an update "has the potential to greatly increase the flexibility of disposal of certain types of LLW, particularly sealed sources and irradiated hardware." [20] The NRC Commission and staff indicated that an overarching goal of the revision would be the integration of a risk-informed performance-based approach to the guidance. In its request for comments to begin the revision process, the NRC noted in particular the disparity between the 4600 curie Class C limit on Cs-137 sealed sources in 10 CFR § 61.55 and the 30Ci limit for disposal for those same sources as described in the 1995 BTP. [21]

Following extensive public and stakeholder engagement, the NRC released a final draft revised BTP in May 2012 ("Draft Revised BTP") [22]. The new guidance will include a revised 'intruder scenario' for determining the reference sealed source waste disposal limits. As a result, the NRC expects the final revision to increase the reference limit for Class C Cs-137 source disposal from 30Ci to 130Ci and the upward disposal limit for Co-60 from 30Ci to 140Ci. The revised BTP is expected to be approved by the NRC Commission in 2014 with little or no change to the sealed source disposal provisions.

While the ability for generators to commercially dispose of disused sealed sources under the revised reference limits is an important and positive development, there is still a significant gap between these limits and the overall Class C limits for commercial sealed source disposal. Cs-137 sources, which are both common and particularly significant from a National security, public health, and safety perspective, provide a key example of the problem. The 10 CFR 61.55 Class C limit for Cs-137 disposed in a 55 gallon drum is 957Ci.[j] Although still under the Class C limit for commercial LLRW disposal, Cs-137 sealed sources between the expected reference limit of 130Ci in the Revised BTP and the Part 61 limit of 957Ci (both averaged over the volume of a 55 gallon) drum remain unaddressed.

However, the Revised BTP will also include guidance on 'alternative approaches' for disposal of LLRW in excess the revised reference limits. Under these provisions,

[j] 957Ci is the 4600Ci Class C limit for Cs-137 averaged over the volume of a 55 gallon drum.

generators may take into account features of the disposal site or disposal containers which would decrease the likelihood of an individual in the future inadvertently encountering waste after the institutional controls are now longer in place. The final draft Revised BTP states that alternative approaches "should provide reasonable assurance that the above referenced scenario is highly unlikely, so long as the source strength exceeds the criteria set in this position (i.e., 4.8 TBq (130 Ci) of Cs-137), and that another scenario is appropriate." [22]

For both sealed and non-sealed source waste, the document describes factors upon which such an 'alternative intruder' scenario could be based, including the climate, geography, and "regional social customs" at the site. The guidance also addresses alternative approaches which do not specify an alternative intruder scenario, but rather provide reasonable assurance that the NRC scenario is not relevant for a particular site, such as depth of burial, intruder barriers, or waste type. This could include "disposal of a sealed source in a robust and long-lived case that cannot be opened easily in the field (the entire package would still require encapsulation), and disposal of the encapsulated item at depths greater than 10 m (33 ft), with evidence that the depth of burial will be maintained for the period that the hazard exists." [22]

The draft Revised BTP further identifies that an alternative approach 'proposal' should contain the following types of information:

- a detailed description of the item(s) (e.g., sealed source(s)).
- a review of the BTP's existing position on encapsulation.
- an overview of the proposed alternative provision (e.g., depth of burial and/or other factors), and how the alternative provision protects the intruder.
- a description of site characteristics pertinent to the proposal.
- a description of any source containing devices and the encapsulating media.
- an analysis of the effects of degradation on packaging and engineered barriers over the period that the item remains hazardous to an intruder.

While the development of the document itself –and the extent to which the NRC involved stakeholders in the process—is a significant accomplishment, it is only the beginning of the work needed practically implement the alternative approach provisions. It will be left to the discretion of the states which host commercial LLRW disposal sites whether or not to allow generators to use the new guidance in the classification of waste for disposal. Those that do wish to adopt the Revised BTP will have to assess and potentially alter the laws, regulations, and license conditions to accord with the revised document. Furthermore, the adoption of the provisions allowing 'alternative approaches' for disposal of sealed source in excess of the reference limits may require site-specific assessments tailored to various types of waste. These time and cost to undertake assess these assessments, of course, will borne by both the disposal sites and the states which regulate them. Having relied on explicit limits for sealed source disposition for so many years, it will take a significant commitment and collaborative effort for sites, regulators, and generators to develop an alternative approach process which meets the needs of all stakeholders.

## Encouraging Sealed Source Disposal: Financial Assurance for Sealed Source Disposal

Despite the successes, the sources disposed under the CRCPD effort are only a fraction of those still disused and in storage. The lower than expected rates of disposal, despite the 50% cost-share offer, has added a new imperative to ongoing discussions regarding policy mechanisms to encourage timely disposal. One such option is to require sealed source licensees to provide financial assurance at the time of purchase sufficient to cover the cost of source disposal. Financial assurance requirements to encourage sealed source disposal have already implemented in the U.S. in NRC Agreement States such as Illinois and Texas.

Financial assurance, generally speaking, is the demonstration of an ability to fund the expected costs associated with specific liabilities. Financial assurance mechanisms are used in industries that require extensive or costly management or decommissioning after the operational and revenue producing life of industrial facilities has ended. NRC, for example, requires financial assurance when licensing facilities that are expected to generate significant amounts of LLRW once the facility ends operations and prepares the site for new occupancy or ownership. However, there are currently no NRC financial assurance requirements aimed at LLRW disposal prior to facility closure. Commonly used mechanisms include letters of credit, surety bonds, or simply cash on deposit.

NRC financial assurance requirements for radioactive materials licensees are similarly aimed at facility decommissioning and generally apply only to sealed source manufacturers and distributors, which keep thousands of sealed sources (and unsealed radioactive materials) in inventory.[k] These requirements are not intended to address management and disposal of sealed sources by generators after use. Table 2 shows the financial assurance thresholds for material types commonly used in risk-significant sealed sources.

**Table 2: NRC Financial Assurance Requirements for Selected Risk-Significant Sealed Sources**

| Radionuclide | IAEA Category 2 Threshold (Ci) | Financial Assurance Threshold (Ci) |
|---|---|---|
| Am-241, Am-241/ Beryllium | 16 | >100 |
| Cf-252 | 5 | >100 |
| Cm-244 | 14 | >100 |
| Co-60 | 8 | >10,000 |
| Cs-137 | 27 | >100,000 |
| Ir-192 | 22 | >1,000 |
| Pu-238 | 16 | >100 |
| Pu-239/Beryllium | 16 | >100 |

[k] See 10 CFR § 30.35 Financial Assurance and Recordkeeping for Decommissioning.

| | | |
|---|---|---|
| Ra-226 | 11 | >100 |
| Sr-90 | 270 | >1,000 |

Prior to the receipt of radioactive materials, licensees subject to these requirements must provide financial assurance in an amount sufficient to cover the estimated cost of decommissioning (or similar amount determined in consultation with the regulator), including the estimated cost of labor, machinery, and LLRW disposal. If a licensee properly disposes of radioactive material during the operational life of the facility, the cost estimate (financial assurance amount) may be reduced accordingly.

In 2006, the Radiation Source Protection and Security Task Force recommended that the NRC consider rulemaking on financial assurance requirements aimed at reducing the risk posed by disused and unwanted sealed sources in storage. In consultation with its Federal and State partners, the NRC completed the evaluation of its financial assurance requirements in January 2010. It considered a variety of appropriate mechanisms, such as broadening the NRC's decommissioning requirements, assessing a source-specific surcharge on a fixed schedule over the life of the source, or imposing a more general surcharge on sealed sources. However, the limited options available to commercial sealed source waste generators (as well as challenges related to a limited supply of LLRW transportation containers), the NRC determined in 2010 not to pursue financial assurance rulemaking. [16] With operations at WCS in Texas now underway, and the likelihood that the Revised BTP will include 'alternative approach' provisions facilitating commercial disposal of sealed sources above the (increased) reference sealed source disposal limits, the Task Force is once again considering a recommendation for the NRC to implement financial assurance requirements. The financial assurance assessment now underway builds off of the prior work of the Task Force and its members.

## CONCLUSION

While many challenges remain with regard to enabling and encouraging sealed source licensees to quickly indentify and dispose of disused and unwanted sealed sources, the Revised BTP and the deliberations regarding financial assurance requirements are highly important steps in the right direction, and represent remarkable progress given the challenging history of sealed source disposal policy and the efforts to overcome these challenges.

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