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Sealed Source Security and Disposition: Progress and Prospects - 13515

Meaghan Jennison*, David W. Martin**, Abigail Cuthbertson***
*National Nuclear Security Administration, Washington, DC,
Meaghan.Jennison@NNSA.Doe.Gov
**National Nuclear Security Administration/Energetics Inc., Washington, DC,
dmartin@energetics.com
*** US DOE, Washington, DC,
abigail.cuthbertson@nnsa.doe.gov

ABSTRACT

Due to their high activity and portability, unsecured or abandoned sealed sources could cause significant health or environmental damage. Further, some of these sources could be used either individually or in aggregate in radiological dispersal devices commonly referred to as "dirty bombs," resulting in significant social disruption and economic impacts in the billions of dollars. Disposal access for disused sealed sources, however, has been a serious challenge. From 2008 to 2012, sealed source disposal was available to only 14 states; additionally, waste acceptance criteria for sealed sources at the low-level waste disposal facilities in operation both prior to and after 2012 exclude some common yet potentially dangerous sealed sources. Recent developments, however, suggest that significant improvement in addressing this challenge is possible, although challenges remain. These developments include 1) the initiation of operations at the Waste Control Specialists (WCS) commercial low-level radioactive waste (LLRW) disposal facility in Andrews County, Texas; 2) the potential for significant revisions of the U.S. Nuclear Regulatory Commission's (NRC) 1995 "Final Branch Technical Position on Concentration Averaging and Encapsulation" (1995 BTP); and 3) the Utah Department of Environmental Quality's (UDEQ) approval of a license variance for sealed source disposal at the Energy*Solutions* LLRW disposal facility near Clive, Utah.

INTRODUCTION

For more than a decade, the Global Threat Reduction Initiative/Off-Site Source Recovery Project (GTRI/OSRP), has facilitated the removal and disposition of thousands of excess, unwanted, abandoned, or orphaned radioactive sealed sources in the U.S. that pose a potential risk to national security, health, and safety. With limited resources, OSRP prioritizes its sealed source recoveries according to security-driven criteria. However, the ability of GTRI/OSRP to continue its work is critically dependent on the ability to transport and commercially dispose of these sources. Until recently, transport and disposal of recovered sources has been facilitated by

nationwide commercial disposal access for many lower-activity sealed sources at the low-level radioactive waste (LLRW) disposal site in Barnwell, South Carolina, and the availability of certified Type B transport container designs. The 2008 decision by the State of South Carolina to discontinue acceptance of out-of-compact waste at the Barnwell facility left 36 states without access to commercial sealed source disposal, until 2012 when WCS began commercial disposal operations in Andrews County, Texas. This has contributed significantly to the current backlog of disused sealed sources registered with GTRI/OSRP.

While precise data on the number and type of disused sealed sources are not readily available, the disused sealed source database administered by GTRI and the Los Alamos National Laboratory gives some indication of the impact of these policy changes. Using 2012 OSRP data as a sample, 18,370 disused sources and 4,348 Ci could be commercially disposed within the Barnwell limits. With the restrictions represented by the closure of Barnwell to non-party states in 2008 , the number amounts to just 1,040 sources representing 162.83 Ci. Import access at WCS in Texas has finally pushed the number and activity of disposable sources back up. Because of the higher activity limits for sealed source disposal at WCS relative to Barnwell, the number of registered sources with disposal access is 19,082, totaling 14,542 Ci. However, when assessing the numbers it is important to keep in mind that because registration is voluntary, these numbers are a sample, but not the actual totals. The number of sealed sources awaiting disposal is most likely significantly higher.

POLICY DEVELOPMENTS

WCS/Texas – Supply, Demand, and the Small Generator Set-Aside

In April 2012, WCS began commercial disposal operations in Andrews County, Texas, becoming the first commercial LLRW disposal site opened since the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) created the compact system in 1985. The WCS site license allows the facility to accept Class A, B, and C LLRW, including sealed sources. While the purpose of the site is to serve the LLRW disposal needs of the two states currently with membership in the Texas Compact, Texas and Vermont, the Texas legislature approved sealed source ‘imports’ –i.e., acceptance and disposal of domestic waste from states other than Texas and Vermont.

While the initiation of disposal activities for Texas and Vermont alone constitutes an important development for sealed source security - Texas, in particular, is the home of more disused sealed sources than any other state - the waste imports have the potential to alleviate many of the sealed source disposal challenges present since 2008. The WCS facility provides a potential disposal pathway for sealed sources stranded by the 2008 closure of Barnwell to non-Atlantic Compact states. Class A waste generators located in states without access to a Compact facility

maintained access to the Energy*Soultions* LLRW disposal site near Clive, Utah. However, the Energy*Soultions* facility license has prohibited it from accepting sealed sources of any waste class for disposal. Furthermore, the new Texas site is able to dispose of sealed sources which exceed Barnwell's activity limits. The Barnwell limit for Cs-137 sealed sources - one of the commonly used sealed source radionuclides and a material of particular concern from a security standpoint - is only 10 curies, well below the 30 curie limit stipulated in the NRC's 1995 BTP. WCS is able to dispose of sources using the limits stipulated in the 1995 BTP, including the 30 curie limit for Cs-137.

Texas Senate Bill 1504 stipulates that WCS may accept up to 50,000 total cubic feet and 220,000 curies of waste from non-compact parties in its first year of operations, followed by a limit of 120,000 curies per year thereafter. The Texas Compact Commission approved rules consistent with Texas SB 1504 in 2011 under the Texas Administrative Code, "Exportation and Importation of Waste" (31 TAC §675.23). The legislation also stipulates that these limits may be revised following a legislatively mandated study on WCS facility capacity, published by the Texas Commission on Environmental Quality (TCEQ), the WCS regulator, in November 2012.[1] The Texas Low-Level Radioactive Waste Disposal Compact Commission is further required to use the study results to anticipate the future capacity needs of the compact waste disposal facility.

The TCEQ report used both Compact and non-Compact generator responses to questionnaires, as well as other available information. The study concluded that 0.73 million cubic feet and 0.08 million curies of operational waste will be generated by 2024, the end of the current WCS license term, and that 1.15 million cubic feet and 0.14 million curies of operational waste will be generated by utility and non-utility generators within the Texas Compact by 2044. WCS has long indicated that it will seek increased annual limits to accommodate disposal demand.

However, with nearly four years between the closure of Barnwell and the opening of the WCS facility, the demand for disposal at WCS of non-Compact Class B and C waste has far exceeded the first year supply of 220,000 curies of import capacity. Just months into the import application process, non-compact generators applied to dispose of more curies than the entire 220,000 allotted for imports in the first year. While some of these applications included sealed sources for disposal, most of the capacity was requested by several large generators, including the Tennessee Valley Authority for over 300,000 curies of power plant waste. It was clear that these large generators had long been preparing for the opportunity to ship long-stored waste to WCS.

The Texas Low-Level Waste Compact Commission ("Texas Commission") recognized the challenge that this imbalance between supply and demand could create for small generators, as

[1] The published report is available at Texas Commission on Environmental Quality, "Capacity Report for Low-level Radioactive Waste: A Report to the 83rd Texas Legislature," SFR-104, November 2012, http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/sfr/104.pdf

well as the resultant impact it could have on sealed source disposition and national security. As demonstrated by the initial import applications, the entirety of disposal import capacity could easily and quickly be consumed by small generators.

To address this challenge, the Texas Commission has agreed to set aside curie and volume capacity at WCS for small generators, initially set at 5,000 curies and 5,000 cubic feet. Since most sealed source users would be classified as small generators under the Texas Commission rules, the development is significant for sealed source disposal and national security. In fact, the Texas Commission explicitly cited the national security importance of sealed source disposition in its support of the set-aside capacity. The Commission's consistent and steadfast attention to the national security implications of sealed source disposal is all the more laudable given the relatively small proportion of waste they represent.

Despite these significant and important developments for sealed source disposition, challenges clearly remain. These challenges are reflected in the low rates with which small generators are applying for disposal at WCS. While the reasons for this surprising outcome are certainly varied, the likely causes likely include both technical and financial challenges. Because they require disposal far less frequently, small generators are likely to lag far behind large generators in the speed with which they can allocate the level of funding required for disposal and initiate disposition activities. This may be especially true of sealed source generators, many of which have not had a disposal pathway since 2008 or longer.

In its first year of considering import applications, the Texas Commission received only five sealed source import applications, totaling 623 curies and 650 cubic feet. However, the data presented in Section I of this paper clearly suggest that these application rates do not reflect the ultimate demand for sealed source disposition. Despite the low number of applications to date, the Texas Commission has indicated no inclination to curtail the set-aside capacity in the future, again citing the importance to national security of sealed source disposal. It intends to set-aside the capacity each year, allocating unused small generator capacity to large generators only at the end of the disposal year.

NRC Revisions to the Branch Technical Position on Concentration Averaging and Encapsulation

While developments in Texas have dramatically increased the number of sealed source generators with access to disposal, a further development has the potential to dramatically impact the activity of the sources generators can dispose. While the tables in 10 CFR § 61.55 clearly identify the Class A, B, and C activity limits for LLRW, the rule also requires that generators determine the concentration of radionuclides in the waste in order to determine its activity for

classification against the § 61.55 tabulated limits.[2] This requirement is aimed at the protection of an inadvertent intruder who may encounter the waste after institutional control of the disposal site has ended. A technical position on radioactive waste classification was initially published in 1983 to assist generators in complying with the waste concentration requirement. The 1995 CA BTP expanded upon and replaced that guidance.[3]

The 1995 BTP is a guidance document, as opposed to a rule. It describes "a subset of concentration averaging and encapsulation practices that the NRC staff would find acceptable" for generators to use in determining the radionuclide concentrations in low-level.[4] However, the 1995 BTP has effectively set the activity limits on commercial sealed source disposal since its publication, explicitly incorporated into many of the rules which govern the state regulation of LLRW disposal facilities.

For gamma-emitting sealed sources, the activity limits for disposal are derived using an intruder scenario in which a hypothetical intruder encounters an intact sealed source and is exposed at 1 meter for 2,360 hours. The activity limit for disposition is set through a calculation of the exposure to which such an intruder would be subject at the time of intrusion, thus varying by radionuclide and waste class. While the scenario and calculation rely on a wide variety of assumptions, limits for some common radionuclides were explicitly identified. For example, the document stipulates a 30 curie limit for Cs-137 sources. The practical effect of this limit is the lack of commercial disposal options for Cs-137 sources with activity levels below the 4,600 curie Class C limit stipulated in 10 CFR § 61.55, but above the 30 curie limit identified in the 1995 BTP. This is all the more concerning because Cs-137 is one of the most commonly used types of sealed sources and one of the most disconcerting from a national security perspective.[5]

In 2007, the NRC staff performed a strategic assessment of the NRC's regulatory program for LLRW. The staff undertook this effort in recognition of significant new and emerging LLW disposal issues, 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,

[2] As stated in 10 CFR § 61.55, "[C]onsideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective. . . . The concentration of a radionuclide (in waste) may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocuries per gram."

[3] The relevant sections on concentration averaging replaced by the 1995 CA BTP are found in Section C.3 of the original 1983 Technical Position. See U.S. Nuclear Regulatory Commission, "Final Waste Classification and Waste Form Technical Position Papers" (1983). Other sections of the 1983 Technical Position remained in effect.

[4] U.S. Nuclear Regulatory Commission, "Final Branch Technical Position on Concentration Averaging and Encapsulation," January 17, 1995 (ADAMS Accession No. ML033630732), cover letter to licensees.

[5] Disposition of another dangerous radionuclide, Co-60 is also highly problematic, but for very different reasons. A 700 curie Class B limit for Co-60 is also indicated in the 1995 BTP (due to its short half-life, there is no Class C limit). However, because of its high energy and associated transportation and handling requirements, the effective disposal limit on Co-60 has been far lower.

particularly sealed sources and irradiated hardware."[6] Following Commission consideration and guidance on staff recommendations, work on the revision began in January 2011. 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 4,600 curie Class C limit on Cs-137 sealed sources in 10 CFR § 61.55 and the 30 curie limit for disposal for those same sources as described in the 1995 CA BTP.[7]

Revised Intruder Scenario

Following extensive stakeholder engagement and comments on an initial draft revision in September 2011, the NRC released its final draft revision in May 2012 for comment ("2012 Draft BTP").[8] The 2012 Draft BTP includes several changes which could have a significant positive impact on national security by increasing the opportunities for disposal of potentially dangerous disused sealed sources. As in the 1995 version before it, much of the guidance regarding sealed source disposal in the 2012 Draft BTP is based on an inadvertent intruder scenario in which an individual encounters an intact Cs-137 sealed source. In the 2012 Draft BTP, however, the NRC refines the scenario based on an "extensive review . . . of the basis for the 1995 policy and an analysis of accidents involving sealed radioactive sources, and a review of approaches used by other countries to regulate disposal of sealed sources."[9] The revised scenario more closely reflects what the NRC staff takes to be a reasonable sealed source "carry-away" scenario and hence to be more risk-informed.[10]

In this scenario, five hundred years after closure of the disposal site (and after the institutional controls have ended), "the waste containers have decayed and the mixable wastes and encapsulating materials have become soil-like. However, a stainless steel Cs-137 sealed radioactive source has survived as an individual, recognizable item."[11] The inadvertent intruder discovers the source and places it in a coat pocket, resulting in an exposure at 3 cm distance for four hours. After four hours the individual places the source in such a location such that he or she is two meters from the sealed source for 15 hours per week, 48 weeks out of the year.

[6] U.S. Nuclear Regulatory Commission, "Strategic Assessment of Low-Level Radioactive Waste Regulatory Program," SECY-07-0180, January 17, 2007.

[7] U.S. Nuclear Regulatory Commission, "Notice of Public Meeting and Request for Comments on the Potential Revision of the Branch Technical Position on Concentration Averaging and Encapsulation," Federal Register, Vol. 76, No. 17, January 26, 2011 at 4739. Available at http://www.gpo.gov/fdsys/pkg/FR-2011-01-26/pdf/2011-1611.pdf.

[8] U.S. Nuclear Regulatory Commission, Final Draft CA BTP. Available at http://pbadupws.nrc.gov/docs/ML1211/ML121170418.pdf.

[9] U.S. Nuclear Regulatory Commission Final Draft CA BTP response to comments, page 67.

[10] As stated in the NRC Final Draft CA BTP response to comments, page 119, "The 1995 BTP established the precedent for the new scenarios, and in the revised draft of the BTP, the staff has used more risk-informed scenarios that result in higher activity limits for disposal of sealed sources."

[11] U.S. Nuclear Regulatory Commission Final Draft CA BTP, page 39.

Sealed source disposal limits for individual radionuclides are then calculated using a 500 mrem exposure limit under the circumstanced portrayed in the scenario. The result is an increase in the Class C limit for disposal of Cs-137 from 30 curies under the 1995 CA BTP to 130 curies in the revised version. While the gap between this revised limit and the 4,600 curie limit for Cs-137 stipulated in 10 CFR § 61.55 will remain a challenge, the opportunity for generators to commercially dispose of Cs-137 sources between 30 curies and 130 curies will have a significant and positive impact on national security, safety, and public health. There are over 2,800 such sources registered with OSRP as disused, totaling over 176,000 curies.

One frequent criticism of the NRC's use of hypothetical scenarios as the basis for both the 1995 BTP and the 2012 Draft BTP guidance is that it unrealistically assumes a probability of 1—i.e., there is no chance that the hypothesized scenario will *not* take place, and furthermore that it will take place the very day after institutional controls are lost (500 years and a single day later in the case of sites with the ability to dispose of Class C waste). While acknowledging the challenges of using hypothetical scenarios generally, the NRC points out that these criticisms are not entirely accurate in this case. In its discussion on the probability of intrusion in the 2012 Draft BTP, NRC cites its determination in another rulemaking that the use an intruder dose limit of 500 mrem/yr instead of 100 mrem/yr is appropriate because intrusion is a "hypothetical" event that may not occur,[12] and that "this higher limit essentially provides for a 20 percent probability of intrusion."[13]

Alternative Approaches

The 1995 BTP references the ability of the NRC or Agreement State regulators under § 10 CFR 61.58 or corresponding Agreement State regulations, to authorize "other provisions for the classification and characteristics of waste on a specific basis . . . ." The regulatory criteria for such exceptions include the "specific characteristics of the waste, disposal site, and method of disposal" as long as they are in compliance with generic site performance objectives described § 10 CFR Part 61.40 to 61.44. However, the authors of the 2012 Draft BTP acknowledge that because the provision "applies to approaches different from those specified in the disposal *regulations*, not in staff *guidance*," it has been used but once, and never for sealed sources.[14] Furthermore, they note that NRC staff believes that the provision has deterred licensees from proposing different averaging approaches and that not all sited states include this provision in their regulations. Given the NRC's current emphasis on encouraging performance-based regulation, the practical outcome of the § 10 CFR 61.58 provision has been particularly unsatisfactory to both the NRC and LLRW generators.

[12] The reference here is to the public dose limit in 10 § CFR Part 20.

[13] See U.S. Nuclear Regulatory Commission, Final Draft CA BTP, page 31.

[14] Emphasis in the original. Maurice Heath, James E. Kennedy, Christianne Ridge, Donald Lowman, John Cochran, "Revision of the Branch Technical Position on Concentration Averaging and Encapsulation," paper presented at the WM2012 Conference, February 26 – March 1, 2012, Phoenix, Arizona, page 12.

To help address this challenge, the 2012 Draft BTP includes relatively extensive guidance for generators to propose alternative approaches to LLRW concentration averaging. For both sealed and non-sealed source waste, the document describes factors upon which an alternative intruder scenario could be based, including depth of burial, intruder barriers, and even the climate, geography, and "regional social customs" at the site.[15] The guidance also addresses alternative approaches which do not offer an alternative intruder scenario, but rather provide reasonable assurance that the NRC scenario is not relevant for a particular site or waste type. For example, for a generator to provide reasonable assurance that the gamma source carry-away scenario is not credible for a specific disposal configuration (site and waste form), a generator could cite packaging in a container that would be unrealistic for an intruder to open at the place and time of discovery, or certify disposal of the encapsulated item at depths greater than 10 meters. An alternative hypothetical scenario based on these factors could result in an increase in the activity of sealed sources which can safely be disposed at existing commercial LLRW facilities.

The NRC expects to release the final revised BTP in 2013. While the development of the document itself –and the extent to which the NRC involved stakeholders in the process—is a significant and laudable success, it is only the beginning of the work needed practically implement the alternative approach provisions. 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.

Energy*Solutions*/Clive Sealed Source License Variance

The Energy*Solutions* LLRW facility near Clive, Utah, is unaffiliated with a Compact and accepts Class A LLRW from authorized generators in all 50 states. However, the Energy*Solutions* license to operate the facility has not permitted it to accept sealed sources of any class or type for disposal. This prohibition was originally put in place due to site-specific factors which in the interim had changed.[16] However, a license variance or amendment would be required in order to lift the restriction.

As the security concerns surrounding the lack of options for sealed source security intensified after 2008, GTRI began working with both Energy*Solutions* and their regulator, the Division of Radiation Control (DRC) at UDEQ to determine which sealed sources might be acceptable for disposal and how to structure a license variance to meet the needs of all parties, including sealed source generators and the general public. The official process for an Energy*Solutions* license variance began with an Energy*Solutions* request for the change, focused on GTRI's threat

[15] See U.S. Nuclear Regulatory Commission, Final Draft CA BTP, page 28.
[16] License Condition l64 to RML UT 2300249 prohibits disposal of sealed sources at the Clive facility.

reduction initiatives and limited to those sealed sources registered as disused with OSRP. Energy*Solutions* presented its request to DRC staff in August 2011.[17] On February 10, 2012, DRC released a draft license variance for a thirty day public comment period. After reviewing and incorporating public comments it received –there were none in opposition to the change— DRC issued a final license variance in April 2012.

Only sealed sources recovered in coordination with the Source Collection and Threat Reduction Program (SCATR), funded by GTRI and administered by the Conference of Radiation Control Program Directors (CRCPD), are authorized for disposal under the variance. Sealed sources under the variance will be disposed at the Energy*Solutions* Clive, Utah facility for a period of one year from the date the first sealed source waste is received at the site. The initiative will include a range of sealed sources that meet the definition for Class A waste. CRCPD is offering financial assistance up to half the cost of disposal to generators who participate in the effort. Among the radionuclides acceptable for disposal are several which are particularly important from a national security, health, and safety standpoint. Each source by itself must meet the definition of Class A waste as defined in § 10 CFR 61.55. Cobalt-60 and cesium-137, two of the most commonly used gamma-emitting radionuclides, are eligible for disposal at Clive, within the specified limits. Table I includes some common radionuclides eligible for disposal under the initiative, along with the activity limits required by the variance.

Table I: Commonly Used Radionuclides and Class A Limits

Isotope	Class A Limit	Isotope	Class A Limit	Isotope	Class A Limit
Co-60	700 microCi/cm3	I-125	700 microCi/cm3	Ir-192	700 microCi/cm3
Cs-137	1 microCi/cm3	Cd-109	700 microCi/cm3	Zn-65	700 microCi/cm3
Gd-153	700 microCi/cm3	Ba-133	Unlimited	Tl-204	700 microCi/cm3
Fe-55	700 microCi/cm3	Ge-68	700 microCi/cm3	Na-22	700 microCi/cm3
Co-57	700 microCi/cm3	Eu-152	Unlimited	Mn-54	700 microCi/cm3
Po-210	700 microCi/cm3	Pm-147	700 microCi/cm3	Au-195	700 microCi/cm3

While the efforts by Energy*Solutions*, DRC, GTRI, and CRCPD are a necessary and unprecedented first step, the importance of the effort can only be judged by the number of sources ultimately disposed under the variance. CRCPD experience and the surprisingly low rates of sealed source disposal thus far at the newly opened WCS LLRW facility in Andrews County, Texas suggest that the process for generators to allocate disposal funding and initiate disposal can be challenging. CRCPD is planning to address these challenges by working with a small subset of states –Illinois, Indiana, New York, and Ohio—to 'pilot' the Clive disposal effort and Class B and C source collections to determine the best process for engaging other states in

[17] On August 2, 2011, Energy*Solutions* submitted to the DRC variance request CDll-0216 to RML UT 2300249. In a meeting on August 18, 2011, Energy*Solutions* presented their request to DRC staff.

the weeks and months thereafter. As currently planned, the one year variance window for disposal at Clive will open on or about June 1, 2013.[18]

CONCLUSION

We will all surely look back at 2012 as a watershed year. Many of the challenges identified by stakeholders since the Barnwell import restrictions took effect in July 2008 have been significantly addressed by the developments described here (and others, such as progress in naming a disposal site for Greater-than-Class C waste). However, with each of these changes, practical and policy challenges must still be addressed. In the case of the developments in both Texas and Utah, logistical and budgetary challenges, which sealed source generators often face as they consider disposal of disused sealed sources, could impede timely progress on disposal. Furthermore, the revised BTP, once final, will take time and effort to implement. Use of the new guidance may not be immediate or may be taken for granted because the 1995 CA BTP has been so thoroughly integrated into norms and rules governing the disposal of low-level waste. Each of the states with operational facilities –South Carolina, Texas, Utah, and Washington—would have to make different and sometimes challenging changes to current rules and practices in order to take advantage of the new guidance, should they choose to do so. "The NRC has agreed to support the transition to the revised guidance, as appropriate and requested by states and generators." Regardless of the challenges, the first steps have been accomplished, and the industry as a whole –states, sites, and regulators included—deserve credit for making 2012 a success for the potential disposition of dangerous sealed sources.

[18] Generators or others with additional questions regarding this opportunity may call or email Russ Meyer at CRCPD at 512-761-3822 or rmeyer@crcpd.org.