Development of New Type-B Containers and the "Alternative Approach" Disposal of High-Activity Sealed Sources – 17385

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ABSTRACT

The DOE/NNSA Office of Radiological Security (ORS) is undertaking two projects to enable the recovery and disposal of high-activity sealed sources. First, ORS has completed the development, certification, and fabrication of a new Type B package to support the recovery and transportation of high-activity sources commonly used in irradiators and cancer treatment devices. A second design is currently undergoing certification. The new containers will enable DOE/NNSA shipment of nearly 100 percent of all commercially used devices containing Cs-137 and Co-60, which are particularly significant from a National security, public health, and safety standpoint. Second, ORS and the Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) are piloting the commercial disposal of a high-activity device under the NRC's revised guidance on concentration averaging and encapsulation. The Cs-137 blood irradiator is being proposed for disposal at the U.S. Ecology facility in Richland, WA. The project is intended to serve as a model for commercial disposal of similar Class C sources that for decades have been without a commercial disposal pathway.

INTRODUCTION

For the past several years, commercial sealed source disposal has been constrained by two important factors. First, limited availability of certified Type-B transportation containers has left some high-activity devices without transport options. It has also significantly increased the cost of leasing the Type-B containers still in service. Second, commercial sealed source disposal options have been highly constrained. Even when generator access to commercial disposal has been available, there has been a significant gap between the radioactivity limits identified in 10 CFR Part 61 as appropriate for near-surface disposal facilities and the radioactivity limits identified in NRC guidance for those same sealed sources. As a result of these constraints, a significant number of disused and unwanted high-activity sealed sources have been relegated to storage, often at the hospitals, laboratories, and industrial facilities where they were formerly used. Because these sources could fall out of regulatory control and be misused, these constraints became a concern from a National security, public health, and safety standpoint.

The Office of Radiological Security enhances global security by preventing high activity radioactive materials from use in acts of terrorism. Facilitating the safe management of these materials, including proper end of life management and disposal, for disused and unwanted sources, is an important part of this work. As result, ORS is undertaking two projects to help address the current transportation and disposal challenges. First, to enable the recovery and disposition of high-activity sources, NNSA, in conjunction with Los Alamos National Laboratory, procured vendor services for the design, testing, and certification of two new Type B transportation packages. Second, ORS is collaborating with the Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) program to pilot the commercial disposal of a high-activity irradiator source under recently revised NRC guidance. If successful, the project could provide a model for the commercial disposal of similar high-activity soures and devices, effectively setting a precedent for a new and important disposal pathway.

TYPE B CONTAINER DEVELOPMENT

In a January 2004 rulemaking, the NRC, in coordination with DOT, adopted revised package design regulations under 10 CFR Part 71 to conform with IAEA standards. In this rulemaking, NRC implemented a planned phase-out of several common Type B packages, with an October 1, 2008 end-date, under the presumption that replacement packages would be designed and certified by the commercial entities that would need them thereafter. Although regulators extended the use of the outdated containers into 2011 through special permits and authorizations, it quickly became clear that few new packages were under consideration, particularly those most appropriate for the transportation of high-activity sealed sources. As a result of these changes, the certified packages available for use became increasingly few in number and expensive to lease. Furthermore, even at the higher prices, the available packages were certified to transport less than 10% of high-activity devices.

ORS recognized in 2009 that these limitations on Type-B container availability could have a serious impact on both commercial sealed source waste disposal and for the ORS/Los Alamos National Laboratory (LANL) Offsite Source Recovery Project (OSRP). Since 2003, NNSA/OSRP has recovered and disposed of tens of thousands of commercial disused sources that could pose a potential threat to National security, public health, and safety. Sources are prioritized based on criteria developed with the NRC, and consist primarily of Co-60, Cs-137, and Am-241. Given the large number of these sources registered with OSRP, those that typically meet the recovery criteria exceed the Type-A transportation package limits, even when the source itself is constructed in a manner to receive special form certification.[a] In addition, OSRP shipments may also include multiple high-activity sources recovered from a single generator. Table 1 below indicates the activity limits beyond which the use of a Type B package is required for the several of the most common risk-significant source types included in OSRP recoveries.

Table 1: Type-A Package Activity Limits for Common Sealed Sources

Radionuclide	A_1 (Special Form)	A_2 (Normal Form)
Am-241	10 TBq (270 Ci)	.001 TBq (0.027 Ci)
Co-60	0.4 TBq (11 Ci)	0.4 TBq (11 Ci)
Cs-137	2 TBq (54 Ci)	0.6 TBq (16 Ci)
Ir-192	1 TBq (27 Ci)	0.6 TBq (16 Ci)
Ra-226	0.2 TBq (5.4 Ci)	0.003 TBq (0.08 Ci)

To enable continued OSRP recovery and disposition of these and other high-activity sources, NNSA and LANL engaged vendors to design, test, and certify two new Type B transportation packages, the 435-B and the 380-B. Together the two containers will enable the shipment of nearly all of the high-activity Cs-137 and Co-60 devices currently in use. Furthermore, in order to encourage and facilitate commercial disposition of disused sealed sources, NNSA will provide the certified container designs to qualified private sector entities that wish to use or modify them to develop packages for commercial use.

[a] Special form materials are typically those with sufficiently high physical integrity that, even under severe accident conditions, radioactive material contamination is highly unlikely. Therefore, larger quantities can typically be shipped in any given package than if the material were not special form (i.e., “normal form”).

435-B Development and Certification

The 435-B is an unshielded, leak-tight Type B container, which can be used to ship common shielded devices, such as disused teletherapy sources and irradiators that use high-activity Co-60 and Cs-137 sources. The container was designed to facilitate both domestic and international recoveries, and can be used in conjunction with the IAEA Mobile Hot Cell and Long Term Storage Shield (LTSS). Furthermore, the container was developed to be transportable by standard 5 ton vehicles in order to enable its use in urban areas or internationally where movement of oversize or overweight shipments is difficult or prohibited. Table 2 below indicates several common devices already approved for transport in the container.

435-B Specifications

- Empty weight: 4,940 lbs. (~2,225 kg)
- Total weight: 10,100 lbs. (~4,535 kg)
- Payload max weight: 3,500 lbs. (~1,590 kg)
- Payload: Shielded Cs-137 or Co-60 devices
- Thermal limit: 200 W thermal limit
- External dimensions: 83 in (209 cm) H x 70 in (179 cm) OD at base
- Internal Cavity: 60 in. (152 cm) x 43 in (110 cm)
- Capable of transport by truck, rail, sea, air

In addition to the devices identified in the table, additional payload either certified or under consideration for the 435-B includes common blood and research irradiators such as the IBL-437C, Hopewell Designs devices; Co-60 teletherapy sources within the LTSS, and the standard 55 gallon drum. Testing and certification of the design was completed in 2015 and OSRP anticipates delivery of 2 units in march of 2017.

Table 2: 435-B Device Payload Currently Certified

Model	Maximum Activity	Nominal Weight (kg)
Gammator B, 50B, B34, G-50-B	15.5 TBq (419 Ci)	816
Gammator M34	71 TBq (1,919 Ci)	839
Gammator M38	142 TBq (3,838 Ci)[a]	1,020
Gammacell 1000 Models A through D and Elite A through D (Type I and Type II)	142 TBq (3,838 Ci)	1,270
Gammacell 3000 Elan A through C, Type I and Type II	112.8 TBq (3,049 Ci)	1,497

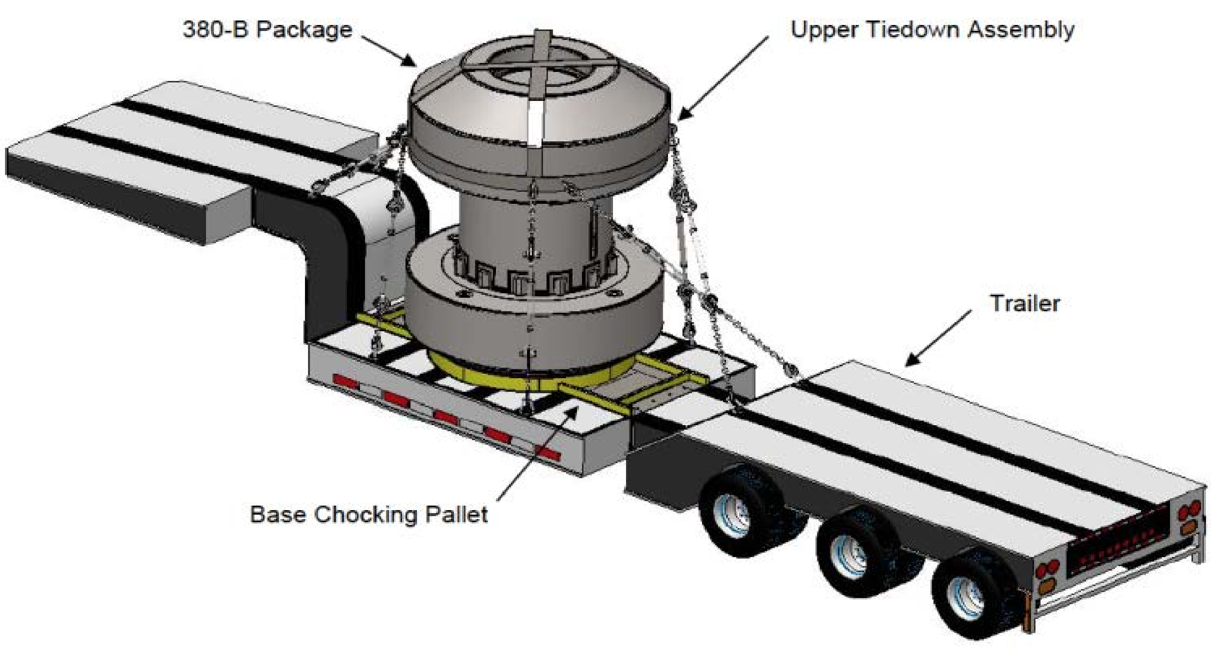
Gammacell-40 (GC-40 Exactor)	83 TBq (2,243 Ci)	1,481
[a] Bounding Value		

The 380-B Shielded Container

Much larger than the 435-B, the 380-B is leak-tight, lead-shielded Type B cask capable of transport by truck, rail, ship, or air. A primary goal in its design is the ability to safely and security transport a wide range of devices without modification. As a result, it will be capable of transporting a majority of the high-activity beta/gamma devices that OSRP expects to encounter in its domestic recovery efforts going forward. Furthermore, as a shielded container, the 380-B can be used for devices where the integrity of the device shielding or device exposure mechanism is not known or is suspect. The 380-B is currently undergoing NRC certification, with initial fabrications and deployment expected in 2018.

380-B Specifications

- Empty weight: 55,000 lbs. (~24,947 kg)
- Licensed package maximum weight: 67,000 lbs. (~30,390 kg)
- Maximum device weight: 10,000 lbs. (~4,535 kg)
- Payload, maximum activities:
  - o Cs-137 = ~1,505 TBq (~40,675 Ci)
  - o Co-60 = ~285 TBq (~7,702 Ci)
- Thermal limit: 205 W
- Overall height: 118 in. (~300 cm)
- Overall diameter: 100 in. (~254 cm) (at impact limiters)
- Inner diameter: 38 in. (~97 cm)
- Inner height to lid: ~48 in. (~122 cm)



ALTERNATIVE APPROACH DISPOSAL

In accordance with the NRC regulations contained in 10 CFR Part 61, Class A, B, and C LLRW in the U.S., including sealed sources, is potentially disposable at "near-surface" disposal facilities, such as those currently operational in South Carolina, Texas, Utah, and Washington. However, disposal limits at these facilities have largely been governed by the NRC's primary disposal guidance for LLRW, the Concentration Averaging and Encapsulation Branch Technical Position (BTP).[b] [1] Until recently, the BTP set the effective limit for disposal of Class C sealed sources at 1.1 TBq (30 Ci), far below the 10 CFR Part 61 upper limits for most common radionuclides. By contrast, the 10 CFR Part 61 Class-C limit for Cs-137 disposed in a 55 gallon drum is 35.4 TBq (957 Ci), while disposal of Co-60 has only a Class A limit of 5.4 TBq (146 Ci) due its short half-life.[c] This disparity is depicted in Table 3 below.

Table 3: Comparison of Sealed Source Disposal Limits Under 10 CFR Part 61 and Prior Disposal Guidance

Radionuclide	10 CFR Part 61 Class C Limit	Prior BTP Limit
Cs-137	≤ 35.4 TBq (957 Ci)	1.11 TBq (30 Ci)
Co-60	None[a]	1.11 TBq (30 Ci)[b]

[a] 10 CFR Part 61 identifies only a Class A limit for disposal of Co-60 sources, but notes that limitations may result from the practical challenges related to the transport and handling of the high energy material.

[b] Because the prior BTP identified a sealed source activity limit for Cs-137 only, its 30 Ci limit was applied to sealed sources generally, including Co-60.

Revised BTP Implementation

The 2015 revisions to the BTP address numerous challenges related to the classification and disposal of LLRW, including several provisions highly important for the disposal of risk-significant sealed sources. These include:

- An increase in the "generic" disposal limit for Cs-137 sealed sources from 1.1

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[b] NRC's regulations at 10 CFR Part 61 require commercial LLRW generators to classify their waste as Class A, B, C, or "Greater-than-Class C" (GTCC), depending on the concentration of certain radionuclides in the waste. The BTP then provides guidance to generators for calculating those concentrations.

[c] The 35.4 TBq (957 Ci) limit for Cs-137 is derived by applying its 10 CFR Part 61, Table 2 Class C limit of 4600 Ci/m^3 to the volume of a 55 gallon drum (0.208 m^3). Similarly, the 5.4 TBq (146 Ci) limit for Co-60 is derived by applying its 700 Ci/m^3 Class A limit in Part 61 to the same volume. Due to its short half life, there are no Class B or higher limits on the disposal of Co-60.

TBq (30 Ci) to 4.8 TBq (130 Ci);[d]

- Identification of a Class A limit for Co-60 sources of 5.2 TBq (140 Ci) and no Class B or C limit due to their short half-life;
- Criteria for site-specific "alternative approaches" that could be used to dispose of sealed sources up to the 10 CFR Part 61 limits, such as 35.4 TBq (957 Ci) for Cs-137 disposed in a 55 gallon drum;
- The ability under the alternative approach provisions to use container volumes larger than 55 gallons for waste classification (potentially increasing the activity of the sealed sources which may be disposed as Class C waste).

Regulators in all four states with operational LLRW facilities have approved the use of the revised BTP, although its ultimate impact on sealed source disposal at sites will vary. South Carolina, for example, has opted to keep the sealed source disposal limit at the Energy*Solutions* Barnwell facility at 370 GBq (10 Ci). Both Waste Control Specialists (WCS) in Andrews County, Texas and US Ecology in Washington have adopted the revised disposal guidance for Class A, B, and C waste, including the increased generic sealed source limits.[e] However, implementation of the alternative approaches for sealed source disposal at these two facilities is still pending, although both expect the provisions to enable disposal of Cs-137 up to the Class C limit 35.4 TBq (957 Ci).[f]

Pilot Disposal at US Ecology in WA

To facilitate its use more generally, ORS is collaborating with the Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat

[d] The BTP specifies "generic" Class A, B, and C limits for several common radionuclides in different waste forms. The NRC deems the specified limits to be generally acceptable at LLRW facilities licensed by the NRC under 10 CFR Part 61 or under corresponding Agreement State regulations.

[e] The Energy*Solutions* Clive, Utah facility is not currently licensed to dispose of sealed sources, although the facility received a license variance in 2012-2013 to facilitate disposal of Class A sources collected under the Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) program. In addition, the Energy*Solutions* has requested a permanent license amendment to enable disposal of Class A sealed sources at Clive up to the limits specified in the revised BTP. It expects to receive approval of this amendment in 2017.

[f] Although disposal of Co-60 sources at the facilities is unlimited from a waste classification standpoint –i.e., there is no Class B or C limit for the material—10 CFR Part 61 indicates that,"[p]ractical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes." The revised BTP does not address these considerations. As a result, it is not clear what, if any, limiting factors there may be for commercial disposal of Co-60 sources at currently operating disposal facilities.

Reduction (SCATR) program and US Ecology in Washington to complete the first commercial high activity device disposal using the alternative approach provisions.[g] The device chosen for the pilot is a disused MDS Nordion Gammacell 1000 (GC1000) irradiator containing two Cs-137 sealed sources. The current combined activity of the sources is ~20.7 TBq (~560 Ci), which significantly exceeds the BTP's generic Class C limit for Cs-137 sources of 1.11 TBq (130 Ci), but is still below the 10 CFR Part 61 Class C limit of 35.4 TBq (957 Ci). The device is licensed in a state with membership in the Rocky Mountain Compact. The goal of the project is twofold. First, to safely and securely remove and dispose of a disused high-activity device that otherwise lacks a commercial disposal pathway. Second, to provide a model that other LLRW generators with similar high activity disused sources or devices can use to request disposal under the revised guidance.

The NRC identifies in the BTP at Volume 1, Section 3.8.2 the types of information most likely pertinent to regulators for assessing alternative approaches to sealed source disposal. In summary, these are factors that could provide reasonable assurance that the inadvertent intruder carry-away scenario that governs the generic disposal limits is not credible for a specific disposal configuration (i.e., site and waste form). These include, but are not limited to:

a) disposal of the item in a robust and long-lived case that cannot be opened easily in the field (the entire package would still require encapsulation); or

b) disposal of the encapsulated item at a sufficient depth to make the carry-away scenario not credible (e.g., 10 meters), with evidence that the depth of burial will be maintained for the period that the hazard exists.

The alternative approach justification for the pilot disposal at US Ecology in WA relies primarily on these features, including:

- ***Physical and radiological characteristics.*** The device contains two Cs-137/chloride source capsules with a combined current activity of approximately ~20.7TBq (~560Ci).[h] Lead shielding within the device reduces the dose rate on its exterior to less than 5 millirem per hour. The irradiator is completely encased by 3/8-inch thick, mild steel plate. The device, including its contents, weighs approximately 1134 Kg (2500 lbs.).

- ***Encapsulation and depth to burial.*** The special-form sources remain in their original manufactured configuration within the device. Each source is a welded double encapsulation constructed of Type 304L stainless steel. The

[g] Funded by a grant from DOE/NNSA, the SCATR program supports the commercial disposal of sealed sources on a cost-share basis. Information on CRCPD/SCATR sealed source recovery and disposal efforts, including current opportunities for support, may be found at http://www.crcpd.org/StateServices/SCATR.aspx.

[h] Manufactured in 1986, the original activity of the device was ~41.5TBq (~1,120Ci).

shielded package is 18” diameter x 24” height, housing approximately 6” of lead shielding between the source and outer steel shell. The package would be further grouted in a US Ecology reinforced steel engineered concrete barrier (ECB), which would protect the embedded steel from corrosion.[i] The irradiator will be buried at a depth of 11.64 meters from the top of the final cover to the middle of the ECB in which it is cemented.

- ***Waste stability***. The device interior consists primarily of lead and steel and meets the stability requirements for disposal at the facility without alteration. The source capsules are held in the source holder at the rear of the sample chamber and are factory welded in place. The sources cannot shift or be removed without extensive grinding and removal of welds, which assures source containment. Void space consists of the sample chamber, the drive cable tube for the turntable, and a small space above the sources. These voids are conservatively estimated to have a total volume of no more than 2 liters, or approximately 2% of the total volume of the irradiator.

The BTP, in sections 3.8.1 and 3.8.3 respectively, also describes ways in which an alternative approach justification might include inadvertent intruder scenarios or timeframes different from the generic assumptions. To enable a comprehensive assessment, the GC1000 proposal also included intruder exposure and intrusion timeframe information. The potential exposure of an inadvertent intruder was adjusted to be consistent with the proposed disposal configuration, and the timeframe for intrusion was impacted by the location of the US Ecology facility within the Central Plateau of the DOE Hanford Site.

CONCLUSION

US Ecology submitted the GC1000 proposed alternative approach to its regulator, the Washington Department of Health (DOH), in late 2016. The facility received and responded to a request for additional information from DOH in January of this year. Unless the submission of further information is required, a formal response is expected in late January or early February. If successful, the effort could create a commercial disposal pathway for similar high-activity sources licensed in the 14 states with membership in the Rocky Mountain and Northwest Compacts. Depending on the outcome of this initial effort, ORS will assess the potential costs and benefits of undertaking a similar commercial disposal project at WCS in Texas.

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[i] As an alkaline material, the concrete used for ECB grouting forms passive and non-corroding oxide film that is generally protective of the reinforced steel used in the ECB, as well as the steel used in the underlying package. As a result, the steel irradiator enclosure is expected to incur minimal erosion during the timeframe that the encapsulation is intact.[2,3]

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Concentration Averaging and Encapsulation Branch Technical Position, Revision 1," Washington DC, 2015.

2. Washington State Department of Health, "Technical Evaluation Report (Revision 2) for US Ecology Steel Reinforced Engineered Concrete Barriers," July 24, 1991.

3. Washington State Department of Health, "Technical Evaluation Report Related to the Report Covering the Evaluation of Potential Dose Pathways from Disposal of Portland General Electric's Trojan Reactor Vessel at US Ecology's Low-Level Radioactive Waste Disposal Facility Richland, Washington, prepared by Chase Environmental Group, Inc." September 1998.