DEVELOPMENT OF THE 435-B (U) PACKAGING FOR RADIOACTIVE SOURCE RECOVERIES IN INTERNATIONAL LOCATIONS

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Abstract

Lacking proper end-of-life management, disused sealed radioactive sources (DSRSs) become increasingly vulnerable to loss, theft and sabotage, which can result in accidents and incidents, including loss of life. Type B quantities of radioactive material can be particularly hard to manage due to complexity and costs associated with their shipment from user's facilities to sites for final disposition or secure long-term storage. Historically, a major part of this issue stems from the lack of certified Type B packaging for safe, secure and legally compliant shipments. To help address this issue, in 2009 the U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA) Office of Radiological Security directed Los Alamos National Laboratory (LANL) to design, test, certify and fabricate Type B packagings for domestic and international use. Through these efforts, the NNSA Model 435-B Type B (USA/9355/B(U)-96) was developed and certified by the U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Transportation (DOT) in 2014. Four of these units have been fabricated for operational use. In 2019, the NNSA donated a 435-B unit to the International Atomic Energy Agency (IAEA) for their international DSRS recovery missions.

1. INTRODUCTION

The OSRP is sponsored by the NNSA's Office of Radiological Security to recover excess, unwanted and abandoned sealed radioactive sources that pose a potential risk to national security and public health and safety. When introduced in 1997, the original mission of the program was to recover and dispose of Pu-239 sources. After the terrorist events on September 11th, 2001, the mission was expanded to address other isotopes that could be used for nefarious purposes, including high activity beta/gamma emitting isotopes such as Cs-137 and Co-60. These isotopes are commonly used for medical and industrial purposes and can be found in virtually all developed areas across the globe. Since 2004, the OSRP has recovered and disposed of well over a million curies of Cs-137 and Co-60 sources, the result of up to 90 device recoveries annually. Each recovery is unique, requiring highly experienced and trained source recovery experts, device packagers and Type B package operators. Figure 1 shows some of the devices containing Category 1 and 2 quantities of Cs-137 and Co-60 sources, commonly recovered by the OSRP.

In 2004, the U.S. Nuclear Regulatory Commission (NRC) revised their regulations in 10 Code of Federal Regulations (CFR) Part 71 to harmonize with the IAEA's 1996 edition of "Regulations for the Safe Transport of Radioactive Material" (IAEA Safety Standards Series No. TS-R-1). In doing so, a number of Type B packaging used by the OSRP and industry for Type B shipments were phased out of use on October 1st, 2008. In anticipation of this change and subsequent lack of certified Type B packaging for compliant shipments, the NNSA's Office of Radiological Security directed the OSRP to design, test, certify and fabricate new Type B container models. This

decade long effort has involved close collaboration between Federal entities, industry experts, the IAEA and a multitude of other stakeholders. To date, two new Type B packaging models, the 435-B and 380-B, have been licensed and fabricated. The 435-B is already in operational use.

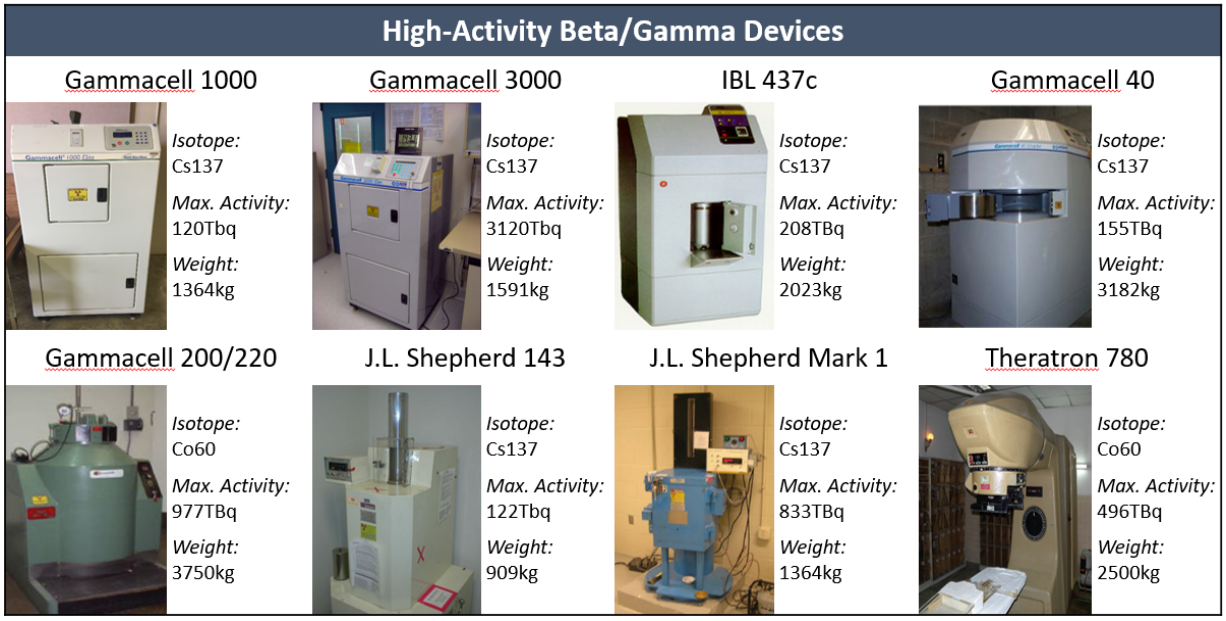

Figure 1. Common irradiation devices recovered by the OSRP

2. 435-B PACKAGING

2.1. 435-B Description

One of the new Type B packagings developed by the NNSA is the 435-B (USA/9355/B(U)-96). This is an unshielded, leak-tight unit with a weight of approximately 2,636 kg empty on its dedicated transport pallet. This packaging was designed to be relatively compact and light for use in congested locations and/or in areas where transport vehicle access is limited due to regional infrastructure (such as unpaved roads). As shown in Figures 2 and 3, the packaging consists of a base, a bell cover which is bolted to the base and internal lodgements which support the long-term storage shield (LTSS), the disposal canisters or large shielded devices. Shielded devices which weigh 1,591kg or less are placed in an inner container for shipment. When loaded and prepared for transport, the 435-B package is 211 cm tall, 178 cm in diameter and weighs a maximum of 4,490 kg. The package is designed to be transported by ground, air or by water in non-exclusive use.

The package is primarily of welded construction using Type 304 austenitic stainless steel. The lodgements are made from welded structural aluminium, the LTSS is made from Type 304 stainless steel and lead, the disposal canisters and the large shielded devices are made from carbon steel and lead, and the inner container is made of Type 304 stainless steel.

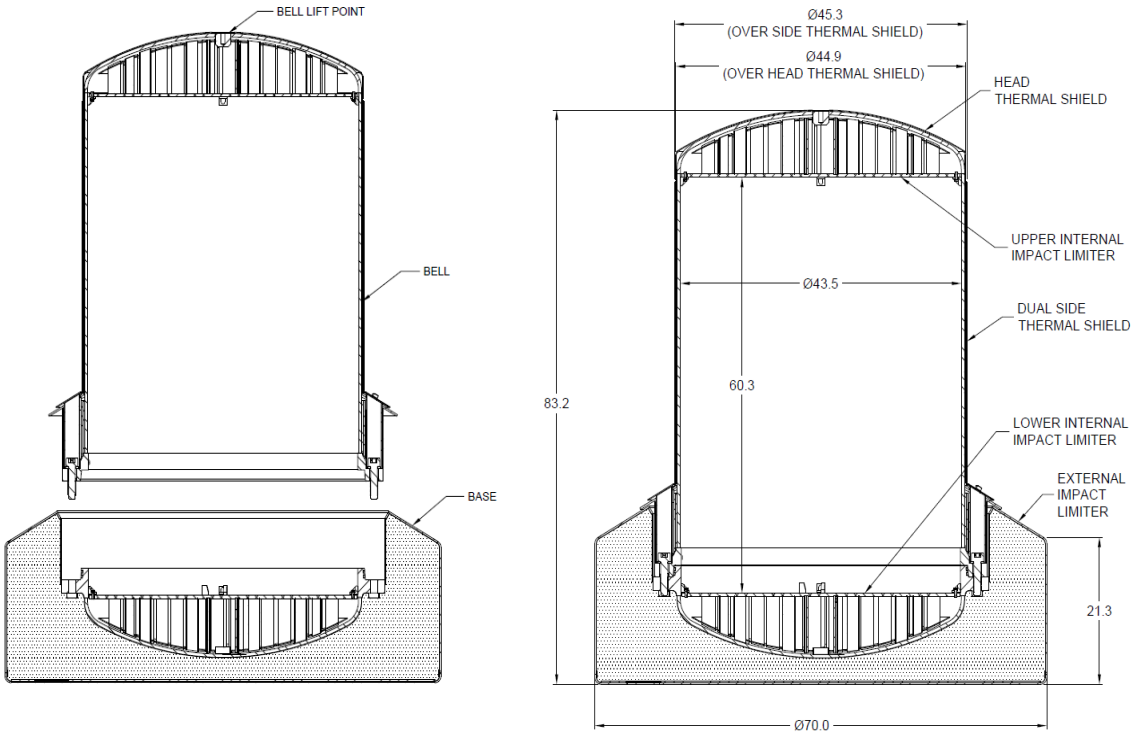

Figure 2. Cross sectional view of 435-B, empty (units in inches)

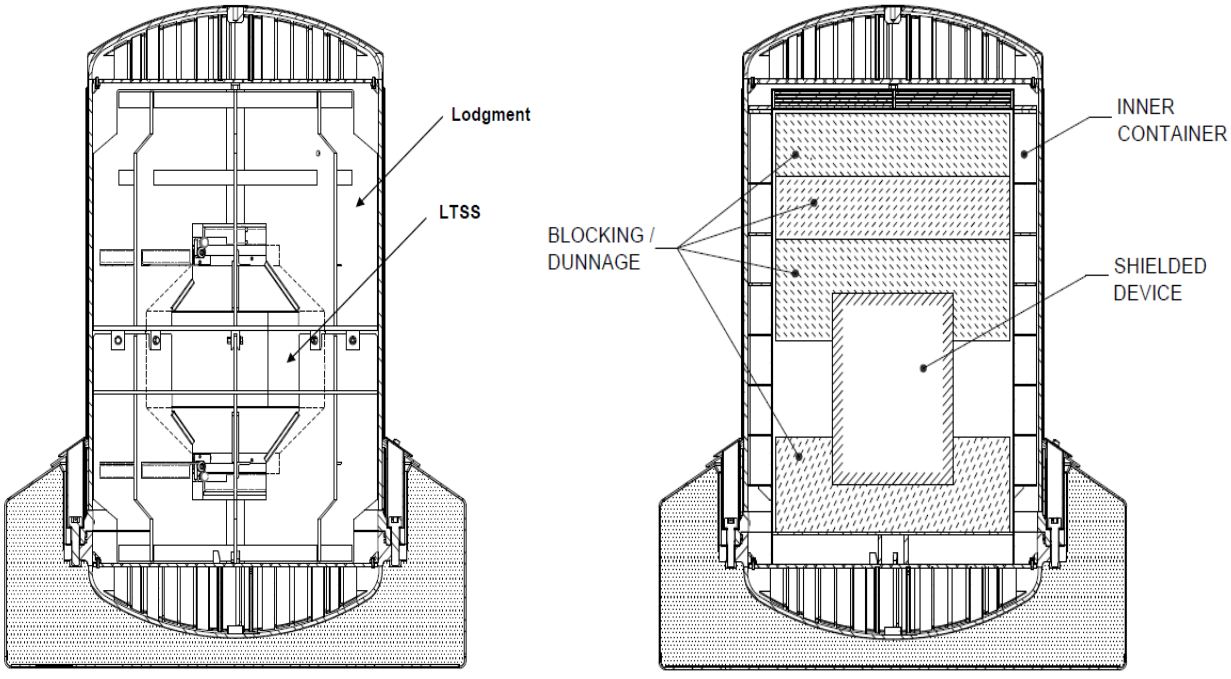

Figure 3. Cross sectional view of the 435-B, loaded (units in inches)

435-B PAYLOADS

The 435-B package is authorized to transport the following payloads:

- The LTSS with a lodgement
- The disposal canister with a lodgement
- A large shielded device with a lodgement
- A shielded device inside an inner container

Maximum source activities in payloads are dependent on the packaging configuration. For beta/gamma emitting sealed sources, maximum activities for the package are possible when loaded with a heavily shielded disposal canister within a lodgement. These activities are shown in Table 1 below. Figure 3 shows cross sectional views of the 435-B with the LTSS within a lodgement and a shielded device within an inner container.

TABLE 1. MAXIMUM ACTIVITIES IN 435-B

Nuclide	Maximum Activity
Co-60	480 TBq
Cs-137	1000 TBq
Sr-90	37 TBq
Ra-226	0.7 TBq
Ra-226Be	0.2 TBq
Ir-192	7 TBq
Se-75	3 TBq

CONTENT APPROVAL

Because the 435-B packaging relies on the source retention and shielding properties of the payloads under both Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC), these properties must first be thoroughly evaluated prior to being added as authorized content. This is an extensive process involving the 435-B design agency, design authority, packaging experts from several DOE laboratories and NNSA representatives. Collectively, this project team assesses proposed changes and modifies the Safety Analysis Report (SAR) (Docket 71-9355) accordingly. The amended SAR is then sent to the U.S. NRC for their review and consideration. Upon approval, the SAR and certificate are updated to reflect the approved changes. To date, the following devices have been approved by the U.S. Nuclear Regulatory Commission (NRC) as authorized content.

- LTSS
- Disposal canister (pending approval)
- Gammator Series
- Gammacell 1000
- Gammacell 3000
- Gammacell 40
- IBL 437C (pending approval)
- Hopewell Designs shielded devices (pending approval)

3. IAEA COLLABORATION

3.1. Mobile Hot Cell and LTSS

In the earliest phases of the 435-B project, OSRP personnel worked with IAEA representatives on desired characteristics of the 435-B packaging. It was anticipated that NNSA would coordinate with the IAEA on international source recovery operations involving the 435-B, in particular large source consolidation projects involving the IAEA's mobile hot cell. This hot cell can be deployed in two 20' ISO containers to countries/regions without fixed hot cell facilities. It is constructed of steel walls assembled on-site and filled with locally sourced sand, which serves as the biological shielding for up to 37 TBq Co-60 equivalent. It has a window filled with a zinc-bromide solution for shielding purposes and uses telescopic master-slave manipulators. The hot cell is used for disassembly of high activity irradiation devices for consolidation of their sources into more transportable configurations.

One wall of the mobile hot cell was designed to mate to the LTSS. The LTSS is a steel-walled, lead-shielded unit with a rotating payload cavity specifically designed for use with the mobile hot cell. Sources removed from devices within the hot cell can be safely loaded into the LTSS using the manipulators and other special tools. As the name suggests, the LTSS was originally designed for storage purposes; however, it can also be used for transportation of DSRSs. One of the original requirements during the design phase of the 435-B was that the LTSS be authorized content.

Figure 4. LTSS mated to mobile hot cell

SUMMARY

Lacking proper end-of-life management, disused sealed radioactive sources (DSRSs) become increasingly vulnerable to loss, theft and sabotage, which can result in accidents and incidents, including loss of life. In 2004, the U.S. Nuclear Regulatory Commission revised their regulations to harmonize with the IAEA's safety standards and in doing so, a number of Type B packaging used by the OSRP and industry for Type B shipments were phased out. In anticipation of this change and subsequent lack of certified Type B packaging for compliant shipments, the NNSA's Office of Radiological Security directed the OSRP to design, test, certify and fabricate new Type B container models. This decade-long effort has involved close collaboration between Federal entities, industry experts, the IAEA and a multitude of other stakeholders. To date, two new Type B packaging models, the 435-B and 380-B, have been licensed and fabricated and the 435-B is in operational use. The 435-B is an unshielded, leak-tight unit designed to be relatively compact and light for use in congested locations and/or in areas where transport vehicle access is limited due to regional infrastructure (such as unpaved roads). The package is designed to be transported by ground, air or by water in non-exclusive use.

ACKNOWLEDGEMENTS

We would like to acknowledge NNSA's Office of Radiological Security for their foresight in seeing the need for new Type B packagings and sponsoring their development. We would also like to acknowledge the IAEA for assisting in designing these containers to work with the mobile hot cell and LTSS.