United States Government Accountability Office

Report to the Committee on Armed Services, House of Representatives

November 2023

HIGH-RISK RADIOACTIVE MATERIAL

Opportunities Exist to Improve the Security of Sources No Longer in Use

GAO-24-105998

GAO Highlights

Highlights of GAO-24-105998, a report to the Committee on Armed Services, House of Representatives

November 2023

HIGH-RISK RADIOACTIVE MATERIAL

Opportunities Exist to Improve the Security of Sources No Longer in Use

Why GAO Did This Study

Radioactive sources are commonly used for medical, industrial, and research purposes. However, these materials can be harmful and dangerous, if used improperly.

NRC and states to which it has delegated authority issue licenses for the possession and use of radioactive sources. These entities regulate disposal facilities that can accept certain sources and waste. Several federal programs support disposal of some sources, but some licensees still hold onto sources beyond their useful lives. Doing so increases the risk that sources could be orphaned and misused, for example, in a dirty bomb.

House Report 117-118 accompanying a bill for the National Defense Authorization Act for Fiscal Year 2022 includes a provision for GAO to review the disposition of radioactive sources. This report examines (1) the factors that contribute to licensees delaying disposal of disused high-risk radioactive sources, and (2) leading practices that, if implemented, could help address challenges related to the disposal of some disused radioactive sources. GAO reviewed relevant laws, regulations, and key organizations' documents on leading practices. GAO also interviewed agency and industry officials and conducted site visits.

What GAO Recommends

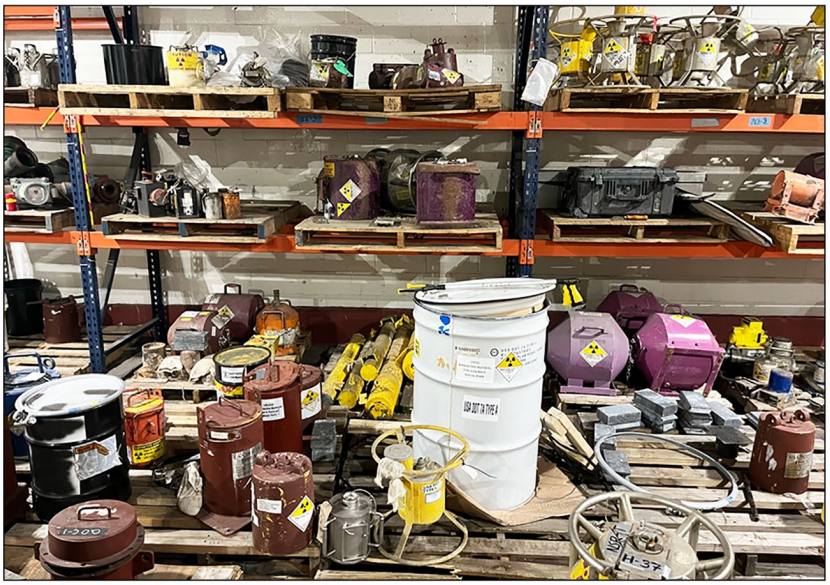
GAO is making three recommendations, including that NRC should assess leading practices that would minimize the time that disused sources are in a licensee's possession. NRC neither agreed nor disagreed with this recommendation, and the agencies generally agreed with the other two recommendations.

View GAO-24-105998. For more information, contact Allison Bawden at (202) 512-3841 or bawdena@gao.gov.

What GAO Found

Licensees of high-risk radioactive sources may delay disposing of sources that are in their possession but no longer in use (i.e., disused) for a variety of reasons. For example, the U.S. Nuclear Regulatory Commission (NRC) does not require licensees to dispose of radioactive sources unless a licensee is terminating all activities under its license at specific locations. In addition, some high-risk sources containing radioactive materials that have a long life cycle, including cesium-137 and americium-241, have limited disposal pathways that may require government assistance or may not have a viable disposal pathway at all. Specifically, sources used in the oil and gas industry that contain americium-241 of foreign origin currently have no permanent disposal pathway, leaving them vulnerable to loss or abandonment.

Disused High-Risk Radioactive Sources at a Source Processing Facility



Source: GAO. | GAO-24-105998

GAO identified leading practices supported by key entities—such as the International Atomic Energy Agency—that are not reflected in NRC requirements and could help address some disposal challenges. These practices include tracking sources, imposing limits and fees on possession, or collecting financial assurances at the time a source is purchased to offset later disposal costs. Assessing adoption of these leading practices nationwide may more broadly incentivize timely disposal, potentially reduce overall cost to the government, and reduce the risk that radioactive sources could be used in a dirty bomb.

Contents

Abbreviations

CIRP	Cesium Irradiator Replacement Project
CRCPD	Conference on Radiation Control Program Directors, Inc.
DOE	Department of Energy
DSWG	Disused Sources Working Group
GTCC	Greater Than Class C
IAEA	International Atomic Energy Agency
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
NSTS	National Source Tracking System
OSRP	Off-Site Source Recovery Program
WIPP	Waste Isolation Pilot Plant
WINS	World Institute for Nuclear Security

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

November 30, 2023

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

Radioactive sources—such as americium-241, cesium-137, cobalt-60, and iridium-192—are commonly used throughout the U.S. for medical, industrial, and research purposes. Those engaged in these purposes, often referred to as licensees, are licensed by a federal or state regulator to safely and securely possess and use radioactive sources. However, these materials can be harmful and dangerous if used improperly. For example, terrorists could use even a small amount to construct a dirty bomb, which uses conventional explosives to spread radioactive material. Furthermore, some radioactive sources are used in industries subject to boom-and-bust cycles, raising the potential for them to become orphaned. According to the U.S. Nuclear Regulatory Commission (NRC), which regulates radioactive sources, orphan sources include those that are not under regulatory control and require removal to protect public health and safety from a radiological threat.[1]

In March 2023, President Biden signed a national security memorandum to establish a more comprehensive policy for securing radioactive sealed sources.[2] In addition, the memorandum calls for the permanent disposal or recycling of certain disused and unwanted radioactive sources, which could be used in a dirty bomb.

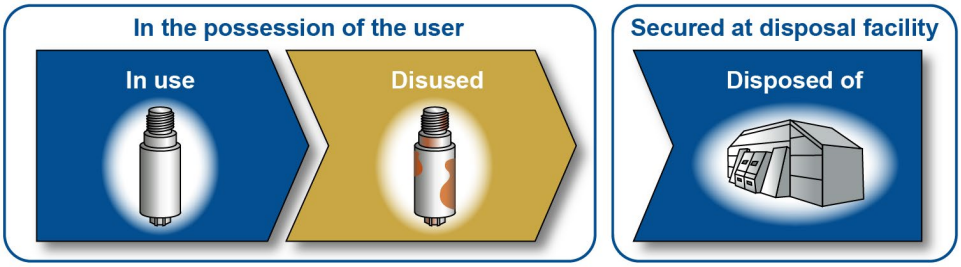
Radioactive sources typically have three phases in their life cycle: (1) the licensee is in possession of and using the source; (2) the licensee is still

[1]The International Atomic Energy Agency (IAEA) partners worldwide to promote the safe, secure, and peaceful use of nuclear technologies. According to the IAEA, an orphan source is a radioactive source that poses sufficient radiological hazard to warrant regulatory control but that is not under regulatory control because it has never been so, or because it has been abandoned, lost, misplaced, stolen, or otherwise transferred without proper authorization.

[2]The White House, “FACT SHEET: President Biden Signs National Security Memorandum to Counter Weapons of Mass Destruction Terrorism and Advance Nuclear and Radioactive Material Security” (Mar. 2, 2023).

in possession of the source, is no longer using it, and has not yet disposed of it (i.e., the source is disused);[3] and (3) the licensee has disposed of the source, and the source is secured at an approved disposal facility (see fig. 1).

Figure 1: Life Cycle of Sealed Radioactive Sources



Source: GAO analysis and illustrations. | GAO-24-105998

Although radioactive sources have a defined period of economic viability based on their half-life and physical condition, licensees sometimes delay disposal of the source, leaving it in the disused phase.[4] In certain circumstances, holding onto radioactive sources in a disused state can increase the risk that sources could become orphaned and raises the potential that a source could be stolen and used in a dirty bomb. This is particularly problematic for sources such as cesium-137 and americium-241, as these sources remain dangerous for many years.[5] Furthermore, we have previously reported that these materials, if stolen and used in a dirty bomb, could result in billions of dollars in socioeconomic damage.[6]

Federal and state entities are both involved in regulating and securing radioactive sources. NRC and certain states, known as agreement states, issue licenses to persons who need to possess and use radioactive

[3]For the purposes of this report, we will refer to sources that are in this second phase as "disused."

[4]Half-life is the length of time it takes for half of the radioactive atoms of a specific radionuclide to decay.

[5]The half-life of cesium-137 is 30.08 years. The half-life for americium-241 is 432.6 years.

[6]These costs could include extensive environmental cleanup, loss of access to homes and business, and deaths from evacuations. GAO, *Combating Nuclear Terrorism: NRC Needs to Take Additional Actions to Ensure the Security of High-Risk Radioactive Material*, GAO-19-468 (Washington, D.C.: Apr. 4, 2019).

materials, and regulate the safety and security of these sources.[7] Agreement states also issue licenses that regulate disposal facilities that accept certain commercially generated waste.[8] The Department of Energy (DOE) is responsible for identifying a disposal pathway, or disposal option, for a certain type of radioactive waste that does not currently have a commercial disposal pathway.[9] DOE's National Nuclear Security Administration (NNSA) has multiple programs that assist private entities either with disposal of certain disused sources or with facilitating transition to alternative technologies. In addition, the NRC and NNSA support the Conference of Radiation Control Program Directors, Inc., (CRCPD) which subsidizes disposal of radioactive sources at commercial disposal facilities and picks up orphaned sources.[10]

House Report 117-118, accompanying a bill for the National Defense Authorization Act for Fiscal Year 2022, includes a provision for us to review the disposal of radioactive sources and the potential to incentivize private industry to dispose of radioactive sources.[11] Our report examines (1) the factors that contribute to licensees delaying the disposal of disused high-risk radioactive sources; and (2) leading practices that, if implemented, could help address challenges related to the disposal of some disused radioactive sources.

[7]The Atomic Energy Act of 1954 gives the U.S. Nuclear Regulatory Commission regulatory authority over domestic industrial, medical, and research uses of radioactive materials. The act also authorizes the NRC to enter into agreements with states (called "agreement states") so they assume, and NRC discontinues, regulatory authority over specified radioactive materials. There are currently 39 agreement states, and the remaining states are known as "NRC states." The NRC and agreement states act as regulators. They license, monitor, track, and require security for radioactive materials in order to protect both workers and the public from exposure to hazardous levels of radiation generated by the activities of licensees.

[8]Existing commercial low-level waste disposal facilities are located in agreement states, including: EnergySolutions Barnwell Operations, located in Barnwell, South Carolina; U.S. Ecology, located in Richland, Washington; EnergySolutions Clive Operations, located in Clive, Utah; and Waste Control Specialists, LLC, located near Andrews, Texas.

[9]Disposal pathways address the various means for safely disposing of these materials so that they will not represent a health and safety risk to current and future populations.

[10]CRCPD is a 501(c)(3) nonprofit nongovernmental professional organization dedicated to radiation protection.

[11]H.R. Rep. No. 117-118, at 338 (2021) (accompanying H.R. 4350, a bill for the National Defense Authorization Act for Fiscal Year 2022).

To evaluate the factors that contribute to licensees delaying the disposal of disused high-risk radioactive sources, we reviewed legislation, regulations, and guidance concerning storage and disposal of radioactive sources. During our initial meetings with the NRC and NNSA, we asked for information on potential contacts to interview. They provided us with approximately 20 contacts, including a wide range of agency officials, state regulators, and industry representatives from small and large licensees. Initial contacts gave us additional sources.

During the engagement, we conducted over 30 interviews to understand the challenges faced by licensees possessing different sources in the disused phase. Specifically, we interviewed officials from the NRC, DOE, NNSA, and six agreement states. We also interviewed six licensees, several radioactive source manufacturers and processors, two industry groups, and one source broker. Using the information we obtained from the interviews, we identified several challenges licensees face that can result in delays to disposing of disused radioactive sources. The findings from these interviews are not generalizable; however, they highlight some common challenges experienced by different groups of licensees and as perceived by different types of stakeholders.

We also traveled to Texas and met with individuals at small, medium, and large private companies that use radioactive sources; source processors; and a private waste disposal facility to observe how they manage sources that are no longer in use. We chose Texas because of the significant size of the oil and gas industry operating in the state and because it has one of the few private waste disposal facilities in the U.S. Finally, we reviewed data from NNSA used to estimate the number of disused radioactive sources in the U.S. We interviewed officials to gain an understanding of the estimate and determined that the data were sufficiently reliable for our purpose of estimating the number of disused foreign-origin americium-241 sources in the U.S.

To evaluate which leading practices certain entities have implemented to help address challenges related to the disposal of some disused radioactive sources, we reviewed relevant documents to identify leading practices recommended by key entities, including the International Atomic Energy Agency (IAEA), the Disused Sources Working Group (DSWG),

and the World Institute for Nuclear Security (WINS).[12] We also interviewed officials from six agreement states identified by the Disused Sources Working Group and NNSA officials, some of which have implemented leading practices that could help address challenges associated with disposal of radioactive sources.[13] We analyzed the results from these interviews to determine what leading practices have been implemented by the different agreement states that address disposal challenges. These results are not generalizable to all agreement states.

We interviewed agency officials at the NRC and NNSA, licensees possessing radioactive sources, the CRCPD, and industry representatives—as identified above—to understand the potential for implementing different mechanisms to incentivize disposal of radioactive sources. Finally, we attended the Low-Level Radioactive Waste Forum and Disused Sources Working Group meetings in October 2022 and March 2023, where we attended sessions related to leading practices for disposal of radioactive materials.

We conducted this performance audit from April 2022 to November 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Uses for Radioactive Sources

Radioactive sources are used in various industrial and medical processes. In the U.S., the radioactive sources most commonly used for medical, industrial, and research purposes are americium-241, cesium-

[12]The IAEA is the world's central intergovernmental forum for scientific and technical cooperation in the nuclear field. It promotes the safe, secure, and peaceful uses of nuclear science and technology. The Disused Sources Working Group is comprised of eight directors of the Low-Level Radioactive Waste Forum. The group solicits input from a broad range of stakeholders, issues reports, and makes recommendations about disposal of radioactive materials. WINS is an international organization whose mission is to improve professionalism and competence in nuclear security worldwide. WINS publishes best practices guides related to nuclear security.

[13]We spoke to officials from the following agreement states: Colorado, Florida, Illinois, New Jersey, Oregon, and Texas.

137, cobalt-60, and iridium-192. For example, americium-241 is used in well logging to examine geologic features around a borehole or well as an aid to searching for oil, gas, and water or conducting environmental or other forms of underground monitoring. Well logging devices are lowered downhole and emit radiation to take readings on the characteristics of an underground formation, such as its chemical and mineral contents. In the medical industry, cesium-137 is widely used in blood irradiators—where donor blood is exposed to radiation, which inactivates a type of white blood cell that may fatally complicate transfusion for some recipients. The most common method of using radiation to treat blood is to place blood bags into a shielded chamber inside of an irradiator containing cesium-137. Cesium-137 is also used in research irradiators to expose cell cultures or animal specimens to gamma radiation. Research irradiators are used to study DNA damage, immune response, cancer development, and other areas. Ultimately, these radioactive sources will reach the end of their lives and need disposal.

Categories of Radioactive Sources and Types of Waste

The U.S. and other nations endorse IAEA's Code of Conduct on the Safety and Security of Radioactive Sources, which establishes basic principles and guidance for the safe and secure use of radioactive sources that are dangerous to human health. It ranks radioactive sources into one of five categories based on their potential to harm human health, if not safely managed or securely protected:

- **Category 1** sources, the most dangerous, are defined as having an activity at least 1,000 times or more than the activity likely to cause permanent human injury. A category 1 source would likely cause permanent injury if handled for more than a few minutes.
- **Category 2** sources are defined as having an activity at least 10 times, but less than 1,000 times, the activity likely to cause permanent human injury to a person who handles them. A category 2 source could cause permanent injury if handled for a short time (minutes to hours).
- **Category 3** sources are defined as having an activity at least the minimum amount but less than 10 times the activity sufficient to cause permanent human injury. A category 3 source could cause permanent injury if handled for some hours.
- **Category 4 and 5** sources are unlikely or unable to cause permanent human injury.

The NRC requires enhanced security controls for licensees possessing category 1 and 2 radioactive materials. This includes national tracking of

certain individual radioactive sources in its National Source Tracking System (NSTS).[14] However, these security controls do not extend to categories 3, 4, and 5. As we have reported in the past, NRC has a threshold of category 1 and 2 sources as part of its requirements to track sources in NSTS.[15] As a result, NRC is not able to easily determine how many category 3, 4, and 5 sources there are in the U.S. nor easily identify where they are located.[16] We have previously recommended that NRC extend its requirements for national source tracking to category 3 sources, given the risks they can pose.[17]

Radioactive sources are disposed at certain facilities based on what types of waste those facilities are set up to accept. NRC regulations classify low-level radioactive waste as Classes A, B, C, or Greater Than Class C (GTCC).[18]

- **Class A** has the lowest radiological hazard and can contain short-lived radionuclides that decay to background levels within a few decades.
- **Class B** contains higher concentrations of short-lived radionuclides than Class A.
- **Class C** contains higher concentrations of both short-lived and long-lived radionuclides than Class B low-level radioactive waste.

[14]NSTS is a transaction-based system that tracks each major step that category 1 and 2 radioactive sources take within the U.S.

[15]GAO, *Nuclear Security: NRC Has Enhanced the Controls of Dangerous Radioactive Materials, but Vulnerabilities Remain*, GAO-16-330 (Washington, D.C.: July 1, 2016).

[16]According to NRC officials, the NRC and agreement states issue licenses that include a condition to indicate the location of use for the radioactive sources. However, this information for category 3, 4, and 5 sources is not centralized.

[17]GAO-16-330. This recommendation has not been implemented.

[18]10 C.F.R. §§ 61.55(a)(2), 72.3. There is no specific crosswalk between the different categories of radioactive sources and the different classes of radioactive waste. Categories of radioactive sources are based on the relative radioactivity of the materials and their impacts on human health. Classes of waste are based on the concentration and half-life of the material. Furthermore, DOE does not use the NRC's waste classification system and instead has different waste acceptance criteria for each of its disposal facilities.

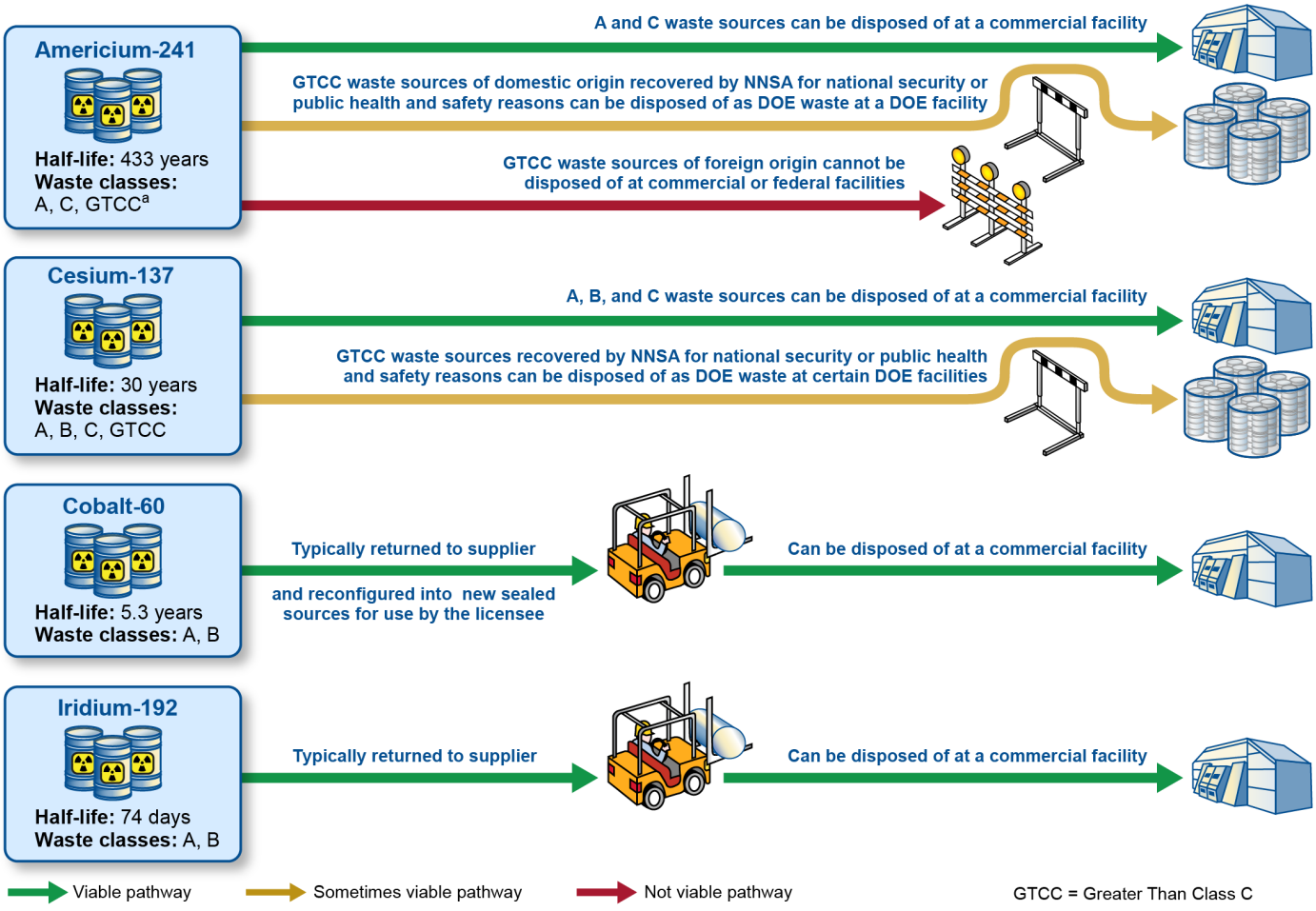
- **GTCC** has concentrations of certain radionuclides that exceed the Class C limits. GTCC is the most radiologically hazardous within the low-level radioactive waste classification.

Waste Disposal Pathways

Although the NRC considers all four of the most commonly used radioactive sources for medical, industrial and research purposes—americium-241, cesium-137, cobalt-60, and iridium-192—to be high-risk radionuclides, different disposal pathways are available based on the concentration and half-life of radionuclides when these sources become disused. Typically, the waste from cobalt-60 and iridium-192 sealed sources can be disposed of at commercial waste facilities, though licensees often return them to suppliers through routine source exchanges that maintain the continued functionality of the device.

By contrast, many cesium-137 and americium-241 sources are more challenging to dispose. Specifically, the half-lives of cesium-137 and americium-241 are much longer than those of cobalt-60 and iridium-192, and the concentrations that would qualify as Class A, B, or C waste are likely much lower than quantities typically used in sealed sources. Thus, the quantity of material in many of the larger sealed sources used in the medical and oil and gas industries would likely render them GTCC waste. Figure 2 shows the different disposal pathways for these radioactive sources.

Figure 2: Disposal Pathways for Americium-241, Cesium-137, Cobalt-60, and Iridium-192



Source: GAO analysis and illustration of DOE and industry information. | GAO-24-105998

Note: GTCC waste cannot be disposed of at a federal facility unless its ownership is first transferred to the federal government and it meets the waste acceptance criteria for disposal at that facility. When disused sealed sources are recovered by the National Nuclear Security Administration (NNSA) for national security or public health and safety reasons, transfer of ownership from the source owner to the Department of Energy (DOE) is officially documented through an Authorization to Transfer/Relinquishment of Ownership/Custody form. These sources may be disposed of at DOE facilities as low-level radioactive waste or transuranic waste if the sources meet the waste acceptance criteria for those facilities.

[a]There is no Class B limit for americium-241 under 10 C.F.R. § 61.55.

Currently, there are commercial facilities in the U.S. that are licensed by agreement states to dispose of Class A, B, and C waste, but there is no commercial facility that can generally accept GTCC waste.[19] Instead, GTCC waste must generally be disposed of in a geologic repository, unless the NRC approves an alternative disposal facility on a case-by-case basis.[20] The nation currently has one geologic repository, the Waste Isolation Pilot Plant (WIPP), in Carlsbad, New Mexico. However, by law, WIPP can only accept transuranic radioactive waste generated by atomic energy defense activities.[21]

In some cases, the federal government can take GTCC from commercial entities and dispose of it at a federal facility. When GTCC is recovered by NNSA for national security or public health and safety reasons, ownership is transferred from the source owner to DOE. Waste owned by DOE may be disposed of at a federal facility as low-level radioactive waste or transuranic waste if it meets the waste acceptance criteria for that facility. Not all such waste may meet waste acceptance criteria, however. Specifically, foreign-origin americium-241 may not be suitable for near surface disposal and also may not meet the waste acceptance criteria for

[19]The federal government is responsible for GTCC disposal under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (1985 Act). Pub. L. No. 99-240 § 102, 99 Stat. 1842, 1844 (1986) (codified at 42 U.S.C. § 2021c(b)(1)(D)). We reported in 2022 that DOE is required by statute to await congressional direction before proceeding with a decision on GTCC disposal for nondefense waste. We suggested that Congress provide direction to DOE on nondefense GTCC waste disposal so that DOE can proceed with a decision. GAO, *Nuclear Waste: DOE Needs to Improve Transparency in Planning for Disposal of Certain Low-Level Waste*, GAO-22-105636 (Washington, D.C.: Sept. 29, 2022). As of September 2023, Congress has not acted on this matter.

[20]The NRC defines a “geological repository” as an excavated underground facility designed, constructed, and operated for safe and secure permanent disposal of high-level radioactive waste. The NRC has taken steps to update its rules regarding GTCC waste disposal. In 2015, the Commission directed NRC staff to prepare a regulatory basis for the disposal of GTCC waste through means other than deep geologic disposal, including near-surface disposal. The NRC issued a draft regulatory basis in 2019 stating that approximately 80 percent of the total volume of all GTCC waste is potentially suitable for near-surface disposal, as long as appropriate controls are implemented and a sufficient site-specific analysis is conducted. In April 2022, the Commission voted to proceed with rulemaking and develop guidance specifically for the near-surface disposal of GTCC waste.

[21]The Atomic Energy Act defines transuranic waste as “material contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium, and that are in concentrations greater than 10 nanocuries per gram, or in such other concentrations as the [NRC] may prescribe to protect the public health and safety.”

WIPP. Under certain circumstances, waste from materials used commercially may qualify as defense waste, but DOE has determined that foreign-origin sources cannot be categorized as defense waste and cannot be disposed of at WIPP. Thus, in certain circumstances, costs for low-level waste that cannot be commercially disposed of, such as GTCC waste from domestic americium-241 and larger cesium-137 sources, are borne by the government through NNSA activities.[22]

NNSA has one program, the Off-Site Source Recovery Program (OSRP), that removes disused sources from licensees and disposes of the material at federal facilities. OSRP typically removes large high-risk sources from licensees to protect against the material being stolen and used in a dirty bomb. NNSA also has the Cesium Irradiator Replacement Project (CIRP), which provides an incentive to remove and replace cesium-137 irradiators from medical and industrial facilities with non-radioisotopic x-ray devices. NNSA also sponsors state-level programs run by CRCPD to provide a subsidy for the disposal of disused sources with commercial disposal options and to help address the recovery of orphan sources.[23]

Risks Posed by Radioactive Sources Outside of Regulatory Control

As we have reported, category 1, 2, and 3 sources could produce billions of dollars of socioeconomic damage if released through a dirty bomb, though the NRC's enhanced security requirements only cover category 1 and 2 sources.[24] Furthermore, our work has demonstrated that the risks of a dirty bomb are increasing. As we reported, the risk of a dirty bomb is determined by the function of three components: threat, vulnerability, and consequence. Threat is generally defined as entities or actions with the potential to cause harm—including terrorist attacks. We previously

[22]DOE classifies radioactive waste as low-level, high-level, or transuranic waste.

[23]CRCPD runs the Source Collection and Threat Reduction Program, which picks up smaller radioactive sources for disposal.

[24]GAO-19-468. We made three recommendations to the NRC, including that it consider socioeconomic consequences and fatalities from evacuations as criteria for determining security measures and require additional security measures for high-risk quantities of certain category 3 radioactive materials. The NRC generally disagreed with the recommendations. However, we continue to believe these recommendations are important.

reported that NNSA assessments of the threat environment show an increasing interest in using radioactive material for making a dirty bomb.[25]

The second component of risk from a dirty bomb, vulnerability, includes physical features or operational attributes that render an asset open to exploitation, including gaps in security measures such as gates, locks, perimeter fences, and computer networks. Our work shows the persistence of vulnerabilities in the security of radioactive materials, particularly for category 3 sources that are not subject to the NRC's enhanced security requirements.[26] Moreover, the potential for orphan sources could create additional vulnerabilities. Finally, the third component of risk from a dirty bomb, consequence, includes the effects from terrorist attacks that could result in impacts to public health and safety and the economy.

Various Factors Contribute to Delays in Disposal of Disused Sources

We identified various factors that contribute to delays in disposal of certain disused sources. First, the NRC does not require licensees to dispose of radioactive sources unless a licensee is terminating all activities under its license at specific locations. Second, licensees do not have an option to dispose of GTCC from foreign-origin americium-241 sources. Third, licensees may delay disposal of GTCC from cesium-137 sources and may rely on government assistance because of the high cost of disposal and the absence of a GTCC disposal facility in the U.S.

[25]GAO, *Alternatives to Radioactive Materials: A National Strategy to Support Alternative Technologies May Reduce Risks of a Dirty Bomb*, GAO-22-104113 (Washington, D.C.: Oct. 21, 2021).

[26]GAO, *Preventing a Dirty Bomb: Vulnerabilities Persist in NRC's Controls for Purchases of High-Risk Radioactive Materials*, GAO-22-103441 (Washington, D.C.: July 14, 2022). We made two recommendations to enhance the security of category 3 sources. We recommended that the NRC (1) immediately require vendors to verify category 3 licenses with the appropriate regulatory authority and (2) add security features to its licensing process that improve the integrity of the process and make it less vulnerable to altering or forging licenses. To address our recommendations, the NRC said it would propose a rulemaking to strengthen licensing. However, vulnerabilities will remain until the NRC implements such a rule. In December 2023, NRC staff plan to publish a proposed rule to revise the agency's radioactive source security and accountability regulations, which, if promulgated, would partially address GAO's recommendations. The final rule is not expected until June 2025.

NRC Does Not Require Licensees to Dispose of All Disused Sources but Has Taken a Step to Promote Disposal

The NRC's regulations cover a number of safety and security requirements for licensees in possession of radioactive sources. However, the NRC's regulations do not include specific requirements for disposing of individual sources when they are disused but still in the possession of the licensee. According to NRC officials and members of the industry we spoke with, the licensee decides when, if at all, to dispose of a source that is no longer suitable. The NRC maintains decommissioning requirements that apply when licensed activities at an entire building, facility, or specific outdoor area cease or are expected to cease, but these do not pertain to individual radioactive sources that have become disused.[27] This lack of regulatory direction for disused source management may contribute to some licensees delaying the disposal of certain high-risk sources, according to a report by the Disused Sources Working Group.[28]

Agency officials and licensees we spoke with recognize an elevated safety and security risk associated with continuing to possess some disused sources, but the NRC maintains that its security requirements are sufficient to address this risk. Specifically, NRC officials told us that licensees' storage of disused sources is not a safety or security concern, as licensees are subject to the same safety and security requirements as long as they possess a source, whether they are using it or not. However, the NRC has acknowledged in official documents that during long periods of storage, sources could become lost, abandoned, or unsecured. In 2015, the NRC stated, "Licensees must store sealed sources for potentially long periods of time if there is no disposal option, and the sources are subject to loss or abandonment."[29] Furthermore, in 2014, the NRC said that "every year, thousands of sources become disused and unwanted in the United States," and "the longer sources remain disused or unwanted, the chances increase that they will become unsecured or

[27]Specifically, licensees must notify the agency and either begin decommissioning or submit a decommissioning plan when (1) their license has expired; (2) they have decided to cease activities at an entire site, building, or specific area that contains residual radioactivity in excess of NRC requirements; (3) no principal activities under the license have been conducted for 24 months; or (4) no principal activities have been conducted for 24 months in a building or specific area that contains residual radioactivity in excess of NRC requirements. 10 C.F.R. § 30.36(d).

[28]Disused Sources Working Group, "A Study of the Management and Disposition of Sealed Sources from a National Security Perspective" (Low-Level Radioactive Waste Forum, Inc.: March 2014).

[29]*Concentration Averaging and Encapsulation Branch Technical Position,* 80 Fed. Reg. 10,165 (Feb. 25, 2015).

abandoned."[30] NNSA officials also told us there is a heightened risk that disused sources could be stolen.[31]

The NRC has taken a step to promote the disposal of high-risk radioactive sources by initiating a rulemaking to revise its financial assurance rules to cover more radioactive sources.[32] Financial assurances require licensees to make arrangements at the time a source is obtained to cover the costs of a source's ultimate disposal.[33] However, until the revised rule is finalized, there is uncertainty as to which sources it will cover. According to the NRC, the revised financial assurance rule may apply to additional category 1 and 2 sources but may not require financial assurances for category 3 radioactive sources.[34] NRC staff told us that they have considered making category 3 sources subject to financial assurance requirements but are still analyzing whether to require financial assurance for some category 3 sources.[35]

[30]Nuclear Regulatory Commission, "NRC Regulatory Issue Summary 2014-04: National Source Tracking System Long-Term Storage Indicator" (May 12, 2014).

[31]This is consistent with The 2022 Radiation Source Protection and Security Task Force Report, an interagency task force composed of the NRC, DOE, and 12 other federal departments or agencies, which stated that the security requirements of 10 C.F.R. Part 37 "provide reasonable assurance against the theft or loss of disused sources; however, the longer sources remain disused or unwanted, the chances increase that they will become unsecured or abandoned."

[32]The NRC's rulemaking would revise 10 C.F.R. § 30.35, "Financial Assurance and Recordkeeping for Decommissioning." If the regulation were revised to include all category 1 and 2 sources, it would substantially reduce the activity threshold for sources requiring financial assurances. For example, the cesium-137 threshold for category 2 is 27 curies, while the 10 C.F.R. § 30.35 threshold for financial assurance is 100,000 curies. For americium-241, the threshold for category 2 is 16 curies, while the 10 C.F.R. § 30.35 threshold for financial assurance is 100 curies. NRC is currently preparing the regulatory basis for the rulemaking and plans to publish the proposed rule in October 2026 and the final rule in December 2027.

[33]For example, the NRC currently requires certain licensees to obtain financial assurances for decommissioning costs. Allowed financial assurance mechanisms include prepayment and sureties, insurance, or other guarantee methods.

[34]National Regulatory Commission, "Staff Requirements – SECY-16-0115 – Rulemaking Plan on Financial Assurance for Disposition of Category 1 and 2 Byproduct Material Radioactive Sealed Sources" (Dec. 8, 2021).

[35]For more information on the history of the NRC's efforts regarding financial assurance, see app, I.

As stated above, the NRC tracks the location of category 1 and 2 sources in NSTS but does not track category 3 sources in NSTS. Therefore, it would be easier for the NRC to implement financial assurance requirements only for category 1 and 2 sources because it can more easily locate these sources. NRC staff acknowledged that not centrally tracking category 3 sources makes it more difficult to hold these licensees accountable for financial assurances. We previously recommended that the NRC extend its requirements for national source tracking to category 3 sources, given the risks they can pose.[36] This recommendation has not been implemented.

Licensees Do Not Have an Option to Dispose of Foreign-Origin Americium-241 Sources, and the Number of Sources Is Likely Increasing Each Year

DOE cannot accept waste containing americium-241 of foreign origin due to DOE's determination that it does not meet the criteria for disposal at WIPP. As a result, GTCC waste from these sources has no disposal pathway.[37] As we stated above, licensees must store sealed sources for potentially long periods if there is no disposal option for them.

For this review, we could not identify the number of category 3 sources in the U.S. that have reached the point in their life cycle where they would likely be disused, because the NRC does not centrally track category 3 sources, as we recommended. However, according to NNSA estimates, there are as many as 1,000 foreign-origin category 3 americium-241 sources in the U.S.,[38] as this type of source is often used in well logging devices in the oil and gas industry. Of these foreign sources, hundreds have likely reached the end of their working life (about 15 years) and are currently disused. In addition, the only new sources currently available are from foreign suppliers because, according to NNSA documents,

[36]GAO-16-330.

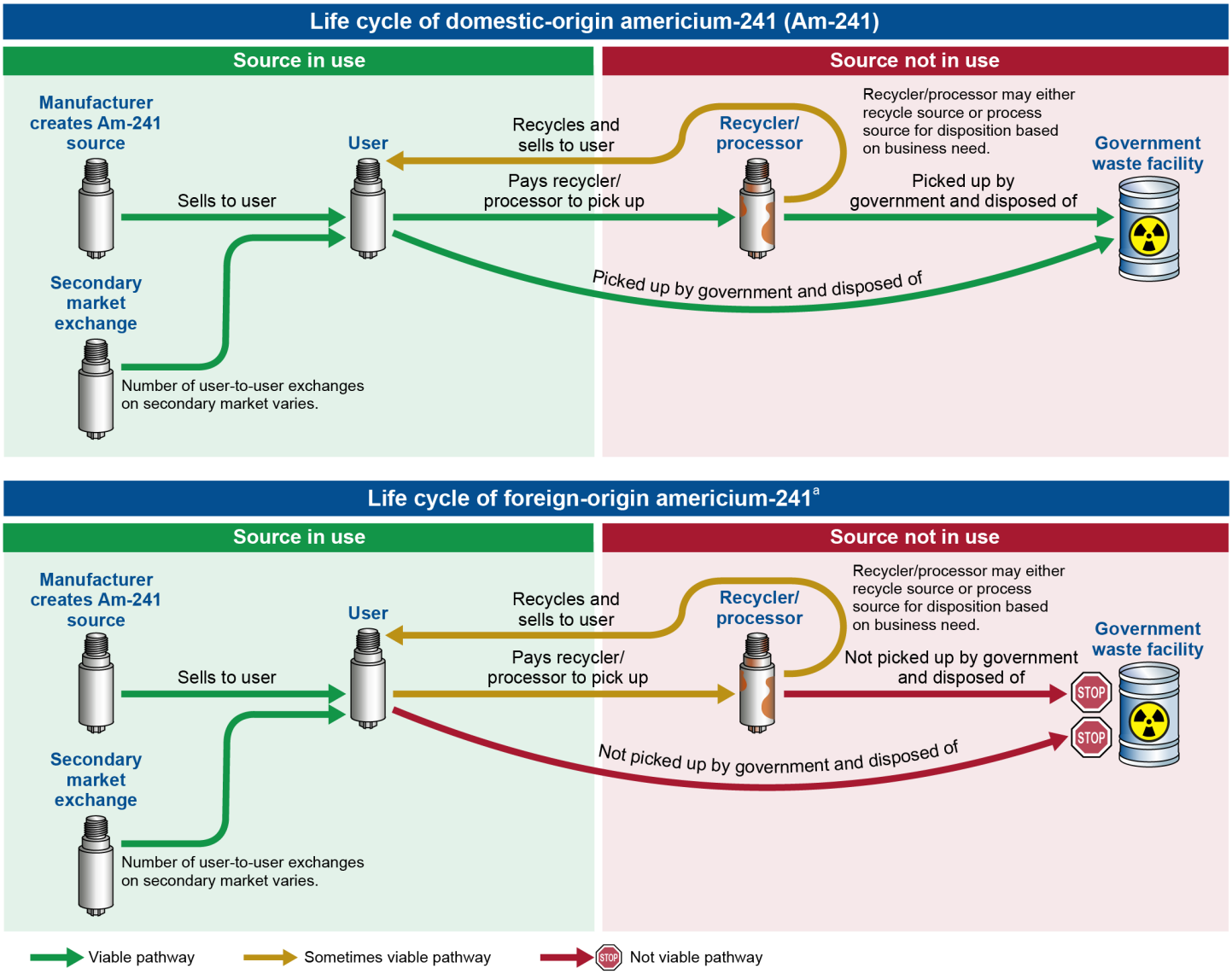
[37]As stated above, GTCC waste from americium-241 sources may not be suitable for near-surface disposal and also may not meet the waste acceptance criteria for DOE's WIPP, the nation's sole geologic repository, because WIPP can only accept radioactive waste generated by atomic energy defense activities. Under certain circumstances, waste from materials used commercially may qualify as defense waste, but DOE has determined that foreign-origin sources cannot be categorized as defense waste and cannot be disposed of at WIPP.

[38]NNSA officials based this estimate on the working life of a typical americium-241 source (10 to 15 years) and the assumption that sources produced after 2003 contained imported americium-241.

domestic suppliers stopped providing americium-241 in 2003.[39] Beyond new sources, according to industry representatives, some used sources can be recycled and returned to service, but it is uncertain how often this occurs or whether recycling activities could be sufficient to meet demand. See figure 3 for the life cycles of both domestic and foreign-origin americium-241 used in well logging devices.

[39]According to a 2011 Los Alamos National Laboratory memorandum, DOE's Isotope Production and Distribution Program stopped selling U.S.-origin americium-241 in 2003, when DOE's inventory of americum-241 was depleted. There is currently no domestic production of americum-241, and DOE has no remaining stocks available for sale. Because of the substantial domestic need, U.S. source manufacturers have been importing Russian-made amercium-241 since at least 2003. Los Alamos National Laboratory, "Use of Foreign-Origin Radioactive Material in Sealed Sources" (Aug. 5, 2011).

Figure 3: Life Cycles of Well Logging Devices Containing Americium-241 Sources, by Their Country of Origin



Source: GAO analysis and illustrations. | GAO-24-105998

Note: Well logging devices are used to search for oil, gas, and water or to conduct environmental or other forms of underground monitoring. Well logging sources typically contain americium-241 and beryllium. The U.S. government produced americium-241 until the late 1980s and provided the isotope to the commercial sector until late 2003. Beginning in the early 1990s, source manufacturers started using foreign-origin americium-241 in industrial applications, and all americium-241 sources in use in the U.S. that are newer than 2003 are foreign in origin.

[a]Foreign-origin americium-241 may not be suitable for near surface disposal but also may not meet the waste acceptance criteria for the Department of Energy's Waste Isolation Pilot Plant (WIPP), the nation's sole geologic repository, because WIPP can only accept radioactive waste generated by

atomic energy defense activities. Under certain circumstances, waste from materials used commercially may qualify as defense waste, but the Department of Energy has determined that foreign-origin sources cannot be categorized as defense waste and cannot be disposed of at WIPP.

Americium-241 Source Recycling and Processing

Recycling and processing companies can offer licensees limited options for facilitating disposal or reuse of disused foreign- and domestic-origin sources. In particular, one U.S. company has the capability to recycle disused well logging devices containing americium-241.

However, the company's representative said it only recycles sources above a certain size, and a majority of the sources it recycles are of domestic origin. According to the company's representative, it may reencapsulate the disused source with a new casing. A well logging business may request this service in order to continue using the source after its casing has deteriorated. The company may also repurpose the radioactive material from the disused source in a new device of a different specification. This company also allows licensees to offload their disused sources by acting as an intermediate storage site for a nominal fee and expedite pickup by the National Nuclear Security Administration's Off-Site Source Recovery Program, according to a company representative.

The company representative said that they routinely receive requests from small well loggers that are shutting down operations and need to get rid of their disused americium-241 sources. In cases when the company will not take the source because it is of foreign origin, it sometimes facilitates the sale of the source to another well logger in the area. Additionally, the representative told us that sources have remained with the well logging entity going out of business in a few instances when the company could not help, creating uncertainty about the ultimate disposal of these sources.

Source: GAO interview with processor. | GAO-24-105998

Given the relatively short working life of these sources, licensees will face increasing numbers of disused category 3 foreign-origin americium-241 sources without a disposal pathway. If the NRC continues to permit licensees to possess foreign-origin americium-241 sources without a disposal pathway, the long-term security of the material could become an issue, as these sources carry an elevated risk of becoming orphaned or stolen. This is because, according to our past work, the oil and gas industry faces boom-and-bust cycles, affecting the financial stability of some well logging companies.[40] Companies that are no longer financially viable are unlikely to be able to store disused sources securely for a long period of time, increasing the risk that these sources could become orphaned, according to officials from the Disused Sources Working Group.

The NRC and DOE each have key roles in the disposal of disused sources to help mitigate the risk of these sources being used in a dirty bomb. Currently, there is no permanent disposal pathway for GTCC sources of foreign-origin americium-241 because it does not meet DOE's criteria to be disposed at WIPP and, as discussed above, DOE is required to await congressional direction before proceeding with a decision on GTCC disposal for nondefense waste. Until a permanent disposal pathway is available, finding a long-term storage solution for foreign-origin americium-241 is important for national security and will require initiative and coordination between the agencies.[41] To date, the NRC has not addressed this issue because it views disused sources as secure while they remain with the licensee, according to agency officials.

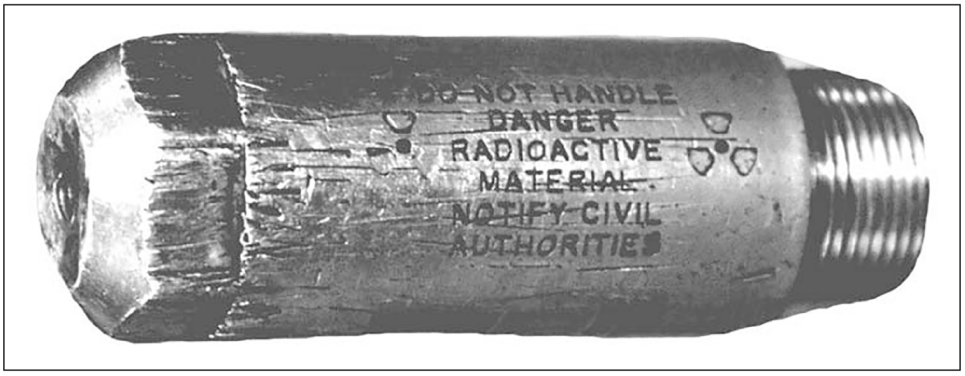
In addition, regulators—the NRC and agreement states—often do not centrally track sources containing category 3 amounts of americium-241 used in well logging devices because they are not required to, making it difficult to determine how many sources may have reached or are nearing the end of their useful lives or whether these sources are of foreign or

[40]GAO, *Unconventional Oil and Gas Production: Opportunities and Challenges of Oil Shale Development*, GAO-12-740T (Washington, D.C.: May 10, 2012).

[41]According to the IAEA, long-term storage of a disused source means storage in a dedicated facility pending disposal. International Atomic Energy Agency, *Guidance on The Management of Disused Radioactive Sources*, Vienna, Austria (2018 ed.).

domestic origin.[42] Further, americium-241 sources used in well logging may move around from licensee to licensee on the secondary market, and these sales may make the sources harder to keep track of. For example, two well loggers with whom we spoke said that their current stock of americium-241 sources was either inherited from a company they acquired or purchased from another well logger. Accordingly, some well loggers may be unaware if their sources are of domestic or foreign origin, which is determined by the date the source was manufactured. Furthermore, licensees told us that the casing that surrounds americium-241 sealed sources can become worn over time, obscuring the serial number used to identify the source. Therefore, it can become more difficult to determine precisely if it is of foreign or domestic origin. (See fig. 4 of a source where the markings are beginning to wear over time.) Our analysis suggests that tracking category 3 sources would have the further benefit of improving regulators' ability to identify the locations of sources that have become orphaned and whether an americium-241 source has a disposal pathway.

Figure 4: Example of a Radioactive Sealed Source That Contains Americium-241



Source: Department of Energy. | GAO-24-105998

Licensees Face a Financial Challenge Disposing of GTCC Waste from Large Cesium-137 Sources

Licensees possessing large cesium-137 sources face a financial challenge in disposing of their sources and typically rely on government subsidies to help with disposal. Large cesium-137 irradiators are likely to be considered GTCC waste and, therefore, cannot be disposed of at a commercial disposal facility. Licensees with these sources can either wait for NNSA to pick up their material or, if possible, arrange with a

[42]The National Academy of Sciences reported in 2008 that the NRC's increased security requirements for category 1 and 2 sources prompted several oil field services companies to consider redesigning their tools to use sources just below the category 2 threshold.

radioactive materials broker—contracted by licensees—to manage the transportation of the disused source to a secure consolidation facility where DOE can assume ownership of the material prior to disposal at federal facilities. However, it may cost $200,000 to $220,000 to dispose of waste from a category 2 quantity of cesium-137, according to a broker. Furthermore, some licensees we spoke with said they were unaware of disposal options and their costs when acquiring these sources. NRC does not require all licensees to set aside funds for disposal when it issues a license. However, some agreement states, IAEA, the Disused Sources Working Group, and the Interagency Working Group on Financial Assurances require or recommend such financial assurances.[43]

Given the challenges licensees face in disposing of their cesium-137 irradiators, NNSA often subsidizes the disposal of these sources through its Off-Site Source Recovery Program and Cesium Irradiator Replacement Project. According to NNSA officials, the agency's projected spending for fiscal year 2022 was almost $59 million to dispose of and replace irradiators with primarily cesium-137 sources, and the agency disposed of 4,273 devices containing cesium-137 sealed sources from approximately 375 recoveries between calendar years 2003 and 2022.[44]

The Off-Site Source Recovery Program currently takes on disposal responsibilities because of the national security risks these sources pose, according to agency officials, as well as to compensate both for the lack of GTCC disposal options and for licensees' inability to pay for disposal. According to NNSA officials, the program could be streamlined if the private sector was able to take on more financial responsibility for disposition. This lack of commercial disposal facilities for GTCC waste includes larger cesium-137 sources.

Given the lack of regulatory requirements to dispose of larger cesium-137 sources, and the lack of a disposal pathway for some, the licensees may store them indefinitely or delay disposal until NNSA picks them up. This increases the risk that disused cesium-137 sources could stay in the

[43]The NRC has initiated a rulemaking to revise its financial assurance requirements. The revised rule may apply to additional category 1 and 2 sources. The NRC plans to publish the final rule in December 2027.

[44]This data was provided by NNSA and includes recoveries and disposals through November 2022.

disused state for an extended period and raises the potential that they could become orphaned. For example:

- A licensee at a medical facility told us that their former employer could not dispose of a disused source due to the cost, and they cited security concerns at the facility where it is stored.
- An official at a medical facility told us they were not confident that they could have disposed of the facility's cesium-137 irradiators without NNSA's financial assistance. They had no idea how much money the disposal would have cost if the facility had to do it on its own. They predicted that without NNSA's financial assistance, the facility would have kept all its cesium-137 sources and accepted the risk associated with possessing them, including the extra security measures.
- A licensee told us that without financial support from NNSA, their institution would probably still have a cesium-137 irradiator. They estimated that it may have cost the hospital $150,000 to $200,000 to dispose of it itself. The hospital had no long-term plan for disposing of the source when it purchased the irradiator, according to the licensee.

Wider Implementation of Leading Practices Could Help Address Some Disposal Challenges

Based on our reviews of key organizations' policies and guidance, we identified leading practices that could help address some disposal challenges that are not reflected in NRC requirements. These practices have been identified by the CRCPD, the Disused Sources Working Group,[45] the IAEA,[46] the Interagency Working Group on Financial

[45]The Disused Sources Working Group is an independent nonprofit organization that was established to facilitate state and compact implementation of low-level waste policy and to promote the objectives of low-level radioactive waste regional compacts.

[46]The IAEA promotes management of radioactive sources through their life cycle, which includes management of disused sources. IAEA guidance establishes a holistic approach focusing on developing national policies, laws, and regulations for managing and maintaining the security of radioactive sources throughout their entire source life cycle, including when they have reached the end of their useful life. This guidance implements the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources. International Atomic Energy Agency, *Guidance on The Management of Disused Radioactive Sources*. The U.S. is among the list of nations that have demonstrated commitment to implement IAEA guidance for the management of disused sources, as of June 2023. https://nucleus.iaea.org/sites/ns/code-of-conduct-radioactive-sources/Pages/default.aspx.

Assurances,[47] the Radiation Source Protection and Security Task Force,[48] and WINS.[49] Some practices have also been implemented by some agreement states, helping manage disused sealed radioactive sources in those states and thus reducing risks associated with the disused phase.

Through our review of key organizations' policies and guidance, we identified six leading practices to address maintaining control over and limiting the period when sources are in disuse.[50] Table 1 outlines leading practices identified by the IAEA, WINS, selected agreement states, interagency working groups, and CRCPD.

[47]The Interagency Working Group on Financial Assurances was established in 2008 to assess concerns related to financial assurances for radioactive material waste. The working group is comprised of several representatives from the NRC; DOE; the U.S. Environmental Protection Agency; and ICF International, LLC, as well as representatives from state regulatory agencies. The NRC considered the working group's 2010 final report in its subsequent activities related to financial assurances for category 1, 2 and 3 sealed sources.

[48]The Radiation Source Protection and Security Task Force was established by the Energy Policy Act of 2005. It is led by the NRC and includes representatives from various federal agencies. According to NRC officials, the task force acts as a vehicle to coordinate and address ongoing challenges involving end-of-life management of category 1 and 2 radioactive sources.

[49]World Institute for Nuclear Security, *A WINS International Best Practices Guide: Security Management of Disused Radioactive Sources* (Vienna, Austria: April 2020).

[50]To identify these leading practices, we reviewed documentation and interviewed officials from six agreement states, one industry group, two governmental organizations, two international organizations, and one nonprofit.

Table 1: Leading Practices for Promoting Management of Radioactive Sources through Their Life Cycle Identified by Key Entities

	Tracking of category 3 sources	Source-specific financial assurances for category 1 and 2 sources only[a]	Source-specific financial assurances for category 1, 2, and 3 sources	Possession fees	Possession limits	Orphan source funds
Agreement states (selected)[b]	X	n/a	X	X	X	X
Conference of Radiation Control Program Directors (CRCPD)[c]	n/a	n/a	n/a	n/a	n/a	X
Disused Sources Working Group[d]	X	n/a	X	X	X	X
Interagency Working Group on Financial Assurances[e]	n/a	n/a	X	X	n/a	n/a
International Atomic Energy Agency (IAEA)[f]	X	n/a	X	n/a	X	X
Radiation Source Protection and Security Task Force[g]	n/a	X	n/a	n/a	n/a	n/a
World Institute for Nuclear Security (WINS)[h]	X	n/a	X	n/a	X	X

Legend: X = implemented, n/a = not applicable

Source: GAO analysis of documents from expert organizations and interviews with agreement state officials. | GAO-24-105998

[a]The U.S. Nuclear Regulatory Commission (NRC) has initiated a rulemaking to revise its financial assurance requirements. The revised rule may apply to additional category 1 and 2 sources. The NRC plans to publish the final rule in December 2027.

[b]Agreement states assume, and the NRC discontinues, regulatory authority over specified radioactive materials. We collected information from officials from the following agreement states: Colorado, Florida, Illinois, New Jersey, Oregon, and Texas.

[c]CRCPD is a 501(c)(3) nonprofit nongovernmental professional organization dedicated to radiation protection.

[d]The Disused Sources Working Group is an independent nonprofit organization that was established to facilitate state and compact implementation of low-level waste policy and to promote the objectives of low-level radioactive waste regional compacts.

[e]The Interagency Working Group on Financial Assurances was established in 2008 to assess concerns related to financial assurances for radioactive material waste. The working group is comprised of several representatives from the NRC; the Department of Energy; the U.S Environmental Protection Agency; and ICF International, LLC, as well as representatives from state regulatory agencies. The NRC considered the working group's 2010 final report in its subsequent activities related to financial assurance for category 1, 2 and 3 sealed sources.

[f]The IAEA is the world's central intergovernmental forum for scientific and technical cooperation in the nuclear field. It promotes the safe, secure, and peaceful uses of nuclear science and technology.

[g]The Radiation Source Protection and Security Task Force was established by the Energy Policy Act of 2005. It is led by the NRC and includes representatives from various federal agencies. According to NRC officials, the task force acts as a vehicle to coordinate and address ongoing challenges, including end-of-life management of category 1 and 2 radioactive sources.

[h]WINS is an international organization whose mission is to improve professionalism and competence in nuclear security worldwide.

These six leading practices reflect four general themes. Adoption of these leading practices may more broadly incentivize timely disposal, potentially reduce overall cost to the government from orphan sources, and reduce the risk that radioactive sources could be used in a dirty bomb. These four themes are (1) source tracking, (2) financial assurances, (3) possession time limits and fees, and (4) orphan source funds.

- **Tracking category 3 sources may help the NRC and agreement states ensure licensees maintain responsibility for the security and disposal of these sources.** As we previously noted, the NRC requires tracking for category 1 and 2 sources only through the NSTS. In contrast, IAEA guidance encourages establishing a national source registry to track category 3 sources as well, as we have recommended.[51]

  We identified one agreement state that has taken the initiative to track category 3 sources throughout their life cycle through internal systems. Specifically, officials from Oregon told us they are able to compare state-maintained inventories to licensee records during periodic inspections. These officials said this information also helps them promote disposal of disused sources through other controls, such as applying possession time limits and imposing financial fees for disused sources held by licensees.

  According to the IAEA, having a national registry to track sources is key to ensuring comprehensive cradle-to-grave management of sources. These same benefits could accrue to category 3 sources if tracked and facilitate the use of other tools, such as establishing financial assurances.

- **Financial assurances may ensure that licensees plan for disposal of certain sources at the time of purchase.** Financial assurances require licensees to make arrangements to cover the costs of a source's ultimate disposal, which licensees told us can be high. According to WINS, financial assurance approaches may vary

[51]GAO-16-330.

according to the regulatory environment.[52] One type of financial assurance could be money set aside and used for disposal when a source becomes disused. Another type of financial assurance could be an upfront refundable surcharge designed to incentivize disposal (i.e., the funds are returned to the licensee when a source is disposed but may not cover the cost of disposal). At a minimum, according to the Disused Sources Working Group, financial assurances may provide (1) some incentive for licensees to limit the time disused sources are kept before disposition and (2) a disincentive from abandoning the source.

The IAEA also recommends establishing financial assurance requirements, and we identified one agreement state, Illinois, which already requires financial assurances.[53] However, as discussed above, the NRC does not specifically require disposal of disused sources, and the agency does not yet require financial assurances for all sealed radioactive sources.[54] Without such assurances, planning for disposal becomes an afterthought, resulting in delays in disposal and reliance on the federal government to pay for disposal of some radioactive sources, according to the DSWG.

Establishing requirements for financial assurances at the time of acquisition could (1) increase awareness of total life cycle costs, (2) help licensees make informed tradeoff decisions on whether to purchase and use nonradioisotopic alternative technologies,[55] (3) mitigate delays in disposal due to cost avoidance by licensees, and (4) lower licensees' reliance on the federal government to pay for disposal.

- **Possession time limits and fees for disused sources may encourage licensees to promptly dispose of these sources.** IAEA recommends minimizing the time that disused sealed sources remain in decentralized storage in order to reduce the risk of a source

[52]World Institute for Nuclear Security, *A WINS International Best Practices Guide*.

[53]Illinois officials noted that their financial assurance requirements cover most category 3 sources.

[54]As discussed, the NRC's financial assurance rulemaking may require financial assurances for more category 1 and 2 sources but may not require financial assurances for category 3 sources.

[55]Replacing technologies that use dangerous radioactive materials with safer, nonradioisotopic alternatives may help protect people and reduce potential socioeconomic costs, if the material was released through a dirty bomb. GAO-22-104113.

becoming orphaned or stolen. In contrast, the NRC does not require licensees to dispose of radioactive sources unless a licensee is terminating all activities under its license at specific locations.

Some agreement states have implemented measures that may minimize the time licensees hold onto sources they no longer use. For example, Texas, Florida, and Oregon have implemented a rule that generally requires licensees to dispose of sources that have not been used in a 24-month period or to justify why they need to keep them, according to state officials. Officials at the Texas Department of State Health Services told us that exemptions may be granted on a case-by-case basis, if properly justified. Additionally, officials in Oregon told us that they impose annual fees for radioactive sources in the possession of licensees beyond the regular licensing fees. The Disused Sources Working Group reported that the fees could be an incentive for licensees to dispose of sources not in use.

- **Orphan source funds provide resources to properly dispose of lost or abandoned sources.** The IAEA recommends establishing funding mechanisms to dispose of orphaned sources and, according to NRC officials, the agency provides a grant to CRCPD to recover orphaned sources nationwide.[56] In addition, as stated above, NNSA, through its Off-Site Source Recovery Program and Cesium Irradiator Replacement Project picks up and disposes of certain large, high-risk sources. However, officials from CRCPD told us that funding is limited. Beyond this, we identified three agreement states—Texas, Illinois, and Florida–that have established their own funds that come from licensing fees. For example, officials from the Texas Department of State Health Services told us that having an orphaned source fund has been useful. However, agreement state officials told us that these funds are limited. For example, Texas officials told us that the amount of money in its fund might not be enough if they were to encounter large orphaned sources or had to dispose of multiple sources at once.

None of these leading practices has yet been adopted nationwide. The NRC has said in response to our previous recommendation that it will not track category 3 sources, but it is currently considering requiring financial assurances for more category 1 and 2 sources. Because the NRC's position is that disused sources are secure so long as they remain with the licensee, it has not assessed, in a comprehensive way, how it could better incentivize disposal of dangerous disused sources by utilizing

[56]As of April 30, 2023, NRC officials told us the agency has spent $83,928 on the current CRCPD grant, with a grant ceiling of $150,000 over the life of the grant.

leading practices recommended by key entities. Not planning for disposal is a potential national security risk, according to NNSA officials. In addition, a recent national security memo states that to reduce the threat of radiological terrorism, the U.S. should permanently dispose of, or recycle, disused and unwanted high-activity radioactive sources.

Conclusions

Radioactive sources provide a key benefit to many industrial and medical applications. However, if not properly used or secured, these sources pose a threat to public safety. For example, they could be stolen and used in a dirty bomb, which could result in billions of dollars in socioeconomic damage. Additionally, sources are used in industries like well logging that are subject to boom-and-bust cycles, which raises the potential for them to become orphaned if a company shuts down. The longer that sources are in a disused state, the higher the risk of loss and abandonment they have. Both the NRC and DOE agree that this risk can endure for a long period for those sources for which there is no disposal pathway and that have long half-lives, such as americium-241. Until a permanent disposal pathway can be agreed upon, the NRC and DOE may reduce these risks by taking action to find secure, long-term storage for disused americium-241 sources.

Further, key entities, including agreement states, have identified or implemented leading practices that may reduce the time that sources remain disused, thereby reducing these risks. The NRC has begun to consider one of these practices—financial assurances—but has yet to take action to implement our prior recommendation to track category 3 sources. Moreover, the NRC has not assessed other leading practices, including possession time limits or fees for disused sources and orphan source funds. Doing so could provide better assurance of the safety and security of these sources and potentially avoid significant socioeconomic consequences.

Recommendations for Executive Action

We are making a total of three recommendations, including one to DOE and two to the NRC. Specifically:

The Secretary of Energy, in coordination with the NRC and in consultation with other relevant stakeholders, should conduct an analysis to evaluate options and take action to facilitate long-term storage, within agency authorities, to better secure foreign-origin americium-241 until a permanent disposal or viable recycling option is available. (Recommendation 1)

The Chairman of the NRC, in coordination with DOE and in consultation with other relevant stakeholders, should conduct an analysis to evaluate options and take action to facilitate long-term storage, within agency authorities, to better secure foreign-origin americium-241 until a permanent disposal or viable recycling option is available. (Recommendation 2)

The Chairman of the NRC should comprehensively assess leading practices that, if implemented, would minimize the time that disused sources are in a licensee's possession. These practices include financial assurances for all category 1, 2, and 3 sources; tracking of category 3 sources; possession time limits or fees for disused sources; and orphan source funds. (Recommendation 3)

Agency Comments and Our Evaluation

We provided a draft of this report to the Secretary of Energy, the Administrator of NNSA, and the Chairman of the NRC for review and comment. DOE, NNSA, and NRC provided written comments, which are reproduced in appendixes II and III, respectively, and summarized below. In addition, DOE, NNSA, and NRC provided technical comments, which we incorporated, as appropriate.

In its written comments, DOE and NNSA agreed with our first recommendation. Specifically, DOE and NNSA agreed to conduct an analysis of options to better secure foreign-origin americium-241 until a permanent disposal or viable recycling option is available, and have initially set April 30, 2024 as the target date for completing their analysis.

In its written comments, NRC generally agreed with our second recommendation and neither agreed nor disagreed with our third recommendation. Specifically, NRC asked for clarification on the second recommendation regarding long-term storage of foreign-origin americium-241. We have clarified our language to better reflect the intent of the recommendation. With regard to the third recommendation, NRC said that it would need to conduct a regulatory analysis prior to implementing the leading practices identified in this report. As we have previously reported, socioeconomic costs totaling billions of dollars in damages could be avoided if a dirty bomb is prevented. In addition, the benefit of these leading practices has already been recognized by some agreement states that have proactively implemented them.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, the Administrator of NNSA, and the

Chairman of the NRC. In addition, this report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or bawdena@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.

Allison Bawden
Director, Natural Resources and Environment

Appendix I: Timeline of Recommendations and Actions Related to Financial Assurances for Radioactive Sealed Sources

The U.S. Nuclear Regulatory Commission (NRC) began exploring the need for financial assurances for additional radioactive sources in 2006, when the Radiation Source Protection and Security Task Force, which it chairs, issued a report recommending the evaluation of financial assurances for category 1 and 2 sources. This report was followed in 2010 by an interagency working group recommendation calling on the NRC and the federal government to adopt financial assurances for category 1, 2, and 3 sources. A further recommendation to require financial assurances for category 1, 2, and 3 sources was issued by the Disused Sources Working Group in 2014. The NRC is preparing the regulatory basis for a rulemaking to revise 10 C.F.R. § 30.35 to include additional category 1 and 2 sources and may explore the viability of requiring financial assurances for category 3 sources. The NRC plans to issue the proposed rule for public comment in October 2026 and the final rule in December 2027. For a detailed timeline, see table 2 below.

Table 2: Timeline of Report Recommendations and Agency Actions Related to Financial Assurances of Radioactive Sealed Sources

Date	Action
2006	In its inaugural report, the Radiation Source Protection and Security Task Force recommends that the U.S. Nuclear Regulatory Commission (NRC) evaluate the financial assurance required for possession of **category 1 and 2** sources to assure that funding is available for the final disposition of these sources.
2010	An interagency working group—created to carry out the evaluation recommended in the 2006 task force report—recommends that the NRC and the federal government adopt a variety of financial assurance models for **category 1, 2, and 3** sources.
2014	The Radiation Source Protection and Security Task Force recommends that the NRC evaluate the need for radioactive source licensees to address the eventual disposition costs of **category 1 and 2** sources through source disposition financial planning or other mechanisms.[a]
2014	The Disused Sources Working Group recommends that the NRC develop financial assurance requirements for all licensees of **category 1, 2, and 3** sources.
2016	NRC staff recommends that the agency expand its financial assurance requirements to include all **category 1 and 2** sources and requests Commission approval to initiate a rulemaking.[b]
2021	The Commission approves the staff's recommendation to initiate a rulemaking to expand the agency's financial assurance requirements to include all **category 1 and 2** sources. As part of this rulemaking, the Commission directs the staff to consider and seek public comment on whether financial assurance requirements should also be extended to **category 3** sources.
2022/2023	The NRC is preparing the regulatory basis to support a rulemaking revising its financial assurance requirements for radioactive materials in 10 C.F.R. § 30.35. Staff told us they expect the rulemaking to address **category 1 and 2** sources and that they are still exploring the viability of covering category 3 sources. The NRC plans to publish the final rule in December 2027.

Source: GAO analysis of regulations and documents from expert organizations and interagency working groups. | GAO-24-105998

[a]Elsewhere in the 2014 report, the task force states the recommendation a bit differently, saying that the NRC should "formally consider supplementing existing requirements" for licensees of category 1 and 2 sealed sources to address disposition costs.

[b]The staff noted that they believe the most prudent use of resources would be for category 1 and 2 sources, which present the highest risk. The staff also said that agreement states could continue to implement more comprehensive financial assurance requirements for sources, including category 3, based on current compatibility categories. Staff were directed by the Commission to consider and seek public comment on whether financial assurance requirements should also be extended to category 3 sources.

Appendix II: Comments from the Department of Energy and the National Nuclear Security Administration

Department of Energy
Under Secretary for Nuclear Security
Administrator, National Nuclear Security Administration
Washington, DC 20585

November 6, 2023

Ms. Allison B. Bawden
Director, Natural Resources
and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Ms. Bawden:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report, *High-Risk Radioactive Material: Opportunities Exist to Improve the Security of Sources No Longer in Use* (GAO-24-105998). The Department of Energy's National Nuclear Security Administration (DOE/NNSA) appreciates GAO's review on the disposition of radioactive materials and shares the auditors' view on the importance of securing high-risk sources that are no longer in use with limited or no permanent disposal pathway.

DOE/NNSA agrees with the auditors' recommendation for DOE/NNSA, in coordination and consultation with the Nuclear Regulatory Commission (NRC) and other relevant stakeholders, to conduct an analysis of options to better secure foreign-origin americium-241 until a permanent disposal or viable recycling option is available. The initial target for completing this analysis is April 30, 2024. Future actions to facilitate any identified long-term storage options will be coordinated with the NRC and other relevant stakeholders.

DOE/NNSA subject matter experts have provided technical and general comments under separate cover for your consideration to enhance the clarity and accuracy of the report. If you have any questions about this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (202) 836-3327.

Sincerely,

Jill Hruby

Appendix III: Comments from the Nuclear Regulatory Commission

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 27, 2023

Allison B. Bawden, Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON DRAFT GOVERNMENT ACCOUNTABILITY OFFICE REPORT GAO-24-105998, "HIGH-RISK RADIOACTIVE MATERIAL: OPPORTUNITIES EXIST TO IMPROVE THE SECURITY OF SOURCES NO LONGER IN USE"

Dear Director Bawden:

Thank you for the opportunity to review and comment on the United States Government Accountability Office (GAO) draft report GAO-24-105998, "High-Risk Radioactive Material: Opportunities Exist to Improve the Security of Sources No Longer in Use," which the U.S. Nuclear Regulatory Commission (NRC) received on September 28, 2023.

We are in general agreement with the findings and first two recommendations. However, we understand the second recommendation to mean that NRC should analyze long-term storage options, which is under our authority. GAO should clarify the second recommendation such that it cannot be read to imply that NRC would be involved in the construction and operation (i.e., implementation) of long-term storage. We understand the intent behind the third recommendation; however, we would need to conduct a regulatory analysis to assess whether there is sufficient safety and security benefit to justify the burden associated with the recommended actions. Tracking of Category 3 sources is not consistent with prior Commission direction, which considered costs and benefits. The staff also has comments on certain statements made in the draft report, which can be found in the enclosure.

If you have any questions concerning the staff's comments, please contact John Jolicoeur. Mr. Jolicoeur can be reached at (301) 415-1642 or by email to John.Jolicoeur@nrc.gov.

Sincerely,

Signed by Dorman, Dan on 10/27/23

Daniel H. Dorman
Executive Director
for Operations

Enclosure:
As stated

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Allison Bawden at (202) 512-3841 or bawdena@gao.gov

Staff Acknowledgments

In addition to the contact named above, Ned Woodward (Assistant Director), Jeffrey Barron (Analyst in Charge), William Bauder, Mark Braza, Antoinette Capaccio, Lilia Chaidez, Craig Comen, Lidiana Cunningham, Scott Henderson, Dan Royer, Caitlin Scoville, and Whitney Starr made key contributions to this report.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through our website. Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. You can also subscribe to GAO's email updates to receive notification of newly posted products.

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, https://www.gao.gov/ordering.htm.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on Facebook, Flickr, Twitter, and YouTube.
Subscribe to our RSS Feeds or Email Updates. Listen to our Podcasts.
Visit GAO on the web at https://www.gao.gov.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact FraudNet:

Website: https://www.gao.gov/about/what-gao-does/fraudnet

Automated answering system: (800) 424-5454 or (202) 512-7700

Congressional Relations

A. Nicole Clowers, Managing Director, ClowersA@gao.gov, (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548

Strategic Planning and External Liaison

Stephen J. Sanford, Managing Director, spel@gao.gov, (202) 512-4707
U.S. Government Accountability Office, 441 G Street NW, Room 7814,
Washington, DC 20548