Report to the President
and the U.S. Congress
Under Public Law 109-58,
The Energy Policy Act of 2005

The 2022 Radiation Source Protection and Security Task Force Report

Submitted by:
The Chairman of the U.S.
Nuclear Regulatory Commission

On Behalf of:
The Radiation Source Protection
and Security Task Force

Executive Summary

The *Energy Policy Act of 2005* (P.L. 109-58) (EPAct) [EPAct, 2005] established the Task Force on Radiation Source Protection and Security (Task Force) to evaluate and provide recommendations to the President and Congress relating to the security of radioactive sources in the United States from potential terrorist threats, including acts of sabotage, theft, or use of a radioactive source in a radiological dispersal device or radiation exposure device. The Task Force presented its initial report to the President and Congress in 2006 [U.S. Nuclear Regulatory Commission (NRC), 2006] and has continued to provide reports every 4 years consistent with the EPAct [NRC, 2010; NRC, 2014a; and NRC, 2018].

MEMBERSHIP OF THE TASK FORCE INCLUDES THE PRINCIPALS OR THEIR DESIGNEES OF THE FOLLOWING ORGANIZATIONS

- *U.S. Nuclear Regulatory Commission*
- *U.S. Department of Homeland Security*
- *U.S. Department of Defense*
- *U.S. Department of Energy*
- *U.S. Department of Transportation*
- *U.S. Department of Justice*
- *U.S. Department of State*
- *Office of the Director of National Intelligence*
- *Central Intelligence Agency*
- *Federal Emergency Management Agency*
- *Federal Bureau of Investigation*
- *U.S. Environmental Protection Agency*

OTHER INVITED AGENCIES

- *U.S. Department of Health and Human Services*
- *Office of Science and Technology Policy*
- *Organization of Agreement States*[1] *(nonvoting member)*

Like the reports that precede it, this report discusses the accomplishments of the Task Force and its member agencies over the past 4 years, as well as the status of actions underway by the Task Force to provide further assurance on the security of sources in all stages of their life cycle. In preparation for this report, the Task Force evaluated the specific topics in the EPAct, including the list of radioactive sources that warrant enhanced protection, mechanisms for the safe storage and ultimate disposal of radioactive sources, transportation security, source tracking, import and export, and ways to facilitate the use of alternative technologies to replace radioactive sources, as appropriate. Based on its evaluation, the Task Force concluded that there are no significant gaps in the area of radioactive source protection and security that are not already being addressed through interagency cooperation and actions. The Task Force remains engaged as a vehicle to coordinate and address ongoing challenges involving end-of-life management of risk-significant (Category 1 and 2) radioactive sources. This report presents the Task Force's 2022 evaluation and recommendations relating to source security.

During this report cycle, the Task Force completed one recommendation from the 2014 report:

- **2014 Recommendation 1**— "The Task Force recommends that U.S. Government agencies assess the adequacy of and coordinate strategies for preventing and mitigating cybersecurity vulnerabilities related to Category 1 and 2 radioactive sources." The Task Force agencies completed significant initiatives for preventing and mitigating cybersecurity vulnerabilities related to Category 1 and 2 radioactive sources. Chapter 1, Subsection II, B, provides additional information on this accomplishment.

[1] Agreement States are States that have entered into formal agreements with the NRC, pursuant to Section 274 of the *Atomic Energy Act of 1954*, as amended (Public Law 83-703) (AEA), to regulate certain quantities of AEA material at facilities located within their borders [AEA, 1954]. Under the AEA, the NRC relinquishes portions of its regulatory authority to license and regulate byproduct materials (radioisotopes), source materials (uranium and thorium), and certain quantities of special nuclear materials (enriched uranium and plutonium) to Agreement States. There are currently 39 Agreement States.

While the Task Force did not identify new recommendations in this report, six recommendations or actions from previous reports remain open as work on them continues: [2]

(1) **2006 Action 9-1**— "The DOE [U.S. Department of Energy] should continue its ongoing efforts to develop GTCC [greater-than-Class-C] [low-level radioactive waste (LLRW)] disposal capability." This action is awaiting "action by Congress" in accordance with Section 631(b)(1)(B) of the EPAct. After action by Congress occurs, the DOE could issue a Record of Decision on its February 2016 final environmental impact statement concerning disposal of GTCC LLRW and GTCC-like waste. Chapter 2, Subsection II, provides recent accomplishments.

(2) **2006 Action 10-2**— "The U.S. Government should encourage suppliers to provide arrangements for the return of disused sources and examine means to reduce regulatory impediments that currently make this option unavailable." This action is ongoing, and the Task Force continues to proactively assess strategies for end-of-life management for risk-significant radioactive sources. Chapter 1, Subsections II and V, provide recent accomplishments.

(3) **2010 Recommendation 4**— "The Task Force recommends that the U.S. Government, regional compacts, and States continue to evaluate disposal options for disused radioactive sources, including options for handling a potentially large number of disused cesium chloride sources that may be replaced once viable alternatives are available." This recommendation is ongoing, and the NRC is undertaking a rulemaking to amend its regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste" to facilitate the disposal of these sources. Chapter 2, Subsection II, provides recent accomplishments.

(4) **2010 Recommendation 5**— "The Task Force recommends that Federal and State Governments investigate options such as providing short-term secured storage of sources recovered from U.S. owners that contain foreign-origin americium [Am]-241 radioactive material, so that these sources can be recovered now, and increase efforts to investigate options for disposal of these sources." This recommendation is ongoing while options are being investigated for secure storage of sources recovered from U.S. owners that contain foreign-origin Am-241 radioactive material. Chapter 2, Subsection II, provides recent accomplishments.

(5) **2010 Recommendation 9**— "The Task Force recommends that the U.S. Government enhance support of short-term and long-term research and development for alternative technologies." This recommendation is ongoing while the DOE National Nuclear Security Administration continues its leadership to proactively research replacement technologies and to incentivize their deployment where feasible, with the assistance of other Task Force agencies. Chapter 3, Subsection II, provides recent accomplishments.

(6) **2014 Recommendation 3**— "The Task Force recommends that the U.S. Government, as appropriate,[3] investigate options such as voluntary, prioritized, incentivized, programs for the replacement of Category 1 and 2 radioactive sources with effective alternatives. The Task Force further recommends that U.S. Government agencies, where appropriate, lead by example in the consideration of and transition to alternative technologies that meet technical, operational, and cost requirements." This recommendation is ongoing. Chapter 3, Subsection II, provides recent accomplishments.

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[2] Appendix I to this report presents a table identifying the specific recommendations that remain ongoing as well as the one closed during this report cycle.

[3] The NRC's statutory mandate precludes it from promoting one technology over another for non-safety or [non-] security reasons. The NRC would review, in accordance with its procedures, any new license application for new technologies.

The Task Force notes the following accomplishments related to radioactive source protection and security since the last report:

- The NRC approved proceeding with rulemaking to expand financial assurance requirements to support safe end-of-life management for certain Category 1 and 2 radioactive sealed sources. This action addresses an NRC subtask under 2006 Recommendation 9-2, to evaluate financial assurance, which was completed in 2010. The NRC also approved proceeding with a new proposed rule that consolidates and integrates criteria for licensing the disposal of GTCC waste and the 10 CFR Part 61 rulemaking, and provides for Agreement State licensing of those GTCC streams that meet regulatory requirements for near-surface disposal and do not present a hazard such that the NRC should retain disposal authority. This action addresses an NRC subtask under 2010 Recommendation 4, to evaluate disposal options for disused radioactive sources.

- The DOE's Office of Environmental Management enhanced the availability of technologies to support the security of radioactive materials in transportation by funding Argonne National Laboratory's development, patenting, and licensing of two remote monitoring systems. This action addresses the EPAct, 2005 mandate to improve the security of transportation of radiation sources.

- The U.S. Department of Homeland Security's (DHS) Cybersecurity and Infrastructure Security Agency published the "Non-Radioisotopic Alternative Technologies White Paper," issued September 2019 [DHS, 2019]. The white paper evaluated the application-specific technical, operational, and cost requirements for existing radioisotopic and non-radioisotopic replacement technologies and devices. This action addresses a DHS subtask under 2010 Recommendation 9, to enhance research and development for alternative technologies.

- The United States [U.S. Mission to International Organizations in Vienna (UNVIE), 2020] made a political commitment to the International Atomic Energy Agency's (IAEA's) Director General to meet the intent of the IAEA's supplementary "Guidance on the Management of Disused Radioactive Sources," issued April 2018 [IAEA, 2018]. The United States continues to promote the use of the IAEA's "Guidance on the Import and Export of Radioactive Sources," issued in March 2005 [IAEA, 2005] and updated in May 2012 [IAEA, 2012]. This action addresses a subtask under 2006 Action 10-2, to support return of disused sources.

This Task Force report is divided into three chapters that detail advances in the security and control of radioactive sources, the status of the recovery and disposition of radioactive sealed sources, and progress in the area of alternative technologies. Actions by the Task Force agencies have assured that radioactive source protection and security are appropriately addressed and that there are no significant gaps in the area of radioactive source protection and security that are not already being addressed through interagency cooperation and actions. Some figures in this report are documented as of April 1, 2022, as a cut-off point to accurately capture frequently changing information.

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Chapter 1: Advances in the Security and Control of Radioactive Sources

During this report cycle, the Radiation Source Protection and Security Task Force (Task Force) assessed the need for changes to the list of radioactive sources and thresholds that warrant additional protection. The Task Force determined that both the list and the thresholds remain appropriate as the framework for identifying those sources that warrant enhanced protection. The Task Force also assessed existing strategies to protect against the use of a radioactive source in a terrorist event and cyber-attacks and determined that current measures for the security and control of radioactive sources are appropriately protective of risk-significant (Category 1 and 2) quantities of radioactive material. As the cybersecurity environment changes rapidly, the Task Force agreed to continue to monitor this issue and include the topic in future Task Force reports.

I. Reevaluation of Radioactive Source Lists

The Task Force has formalized, within its charter, a process to determine the need to reevaluate the list of radioactive materials and the associated thresholds of those isotopes that warrant enhanced security and protection in the United States. This process allows the Task Force to consider whether a full reevaluation is necessary based upon a review of the following key factors: changes in the threat environment and gathered intelligence, changes in isotope production, changes in isotope usage, and changes in primary consequences of concern. The list of radioactive sources and threshold levels is based on the International Atomic Energy Agency's (IAEA's) "Code of Conduct on the Safety and Security of Radioactive Sources," issued January 2004 (Code of Conduct) [IAEA, 2004].

In preparing its 2022 report, the Task Force reviewed and considered key factors to determine whether changes to the list of radioactive sources or threshold levels are warranted. The Task Force concluded that a reevaluation is not warranted at this time. First, although the United States still faces a general threat of terrorism using radioactive sources, the Task Force did not find any specific threat against a specific target in this reporting period. Second, while the use of radioisotopes has evolved, particularly in medical applications, the isotopes that are of main concern based upon their physical characteristics and activity levels have remained appropriate both domestically and internationally, such that the addition of radionuclides or changes in thresholds for the existing list are not justified at this time. Finally, the primary consequences of concern remain valid—namely, deterministic effects (i.e., the ability to cause death or permanent injury) and stochastic effects (i.e., cancer or chronic illness), with additional consideration of economic consequences.

Thus, the Task Force will continue to attend threat briefings and monitor these key factors, and should changes occur, member agencies will take prompt action to reevaluate the source list as appropriate.

II. Security Measures and Initiatives

The Coronavirus Disease 2019 (COVID-19) pandemic has not resulted in decreased compliance with well-established security measures that ensure the security of risk-significant quantities of radioactive material (i.e., Category 1 and 2) in the United States. The U.S. Nuclear Regulatory Commission (NRC) and Agreement States[4] have adjusted oversight processes throughout the pandemic to ensure that licensees continued to meet security requirements that provide for reasonable assurance of adequate protection against theft or diversion of risk-significant radioactive sources in the United States. Federal and State regulators have been conducting both remote and onsite inspections to accomplish their important oversight mission. The NRC and Agreement State regulators have also taken steps to identify areas under their respective jurisdictions that are challenging to oversee under pandemic restrictions, and the areas where flexibilities, such as exemptions, would not compromise the ability of licensees to maintain the safe and secure operation of licensed facilities. For example, an exemption[5] to the general security requirement in Title 10 of the *Code of Federal Regulations* (10 CFR) 37.43(c) for refresher training for individuals was issued because there was not a secure remote training platform available while in-person training was paused. All NRC temporary regulatory exemptions, however, include requirements for licensees to implement compensatory measures that ensure licensed radioactive sources remain safe and secure during use, storage, and in transport.

Consistent with its mission to advance the Nation's protection against radiological terrorism, the U.S. Department of Energy's (DOE's) National Nuclear Security Administration (NNSA) continues to offer voluntary enhancements to augment the security of radioactive sources at facilities nationwide. These enhancements supplement the existing security requirements of 10 CFR Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Materials." As of April 1, 2022, over 600 licensees (representing almost 1,050 buildings containing risk-significant sources) have partnered with the DOE/NNSA to enhance their physical security measures. The DOE/NNSA has expanded its efforts to offer voluntary security enhancements and replacement of sources with alternative technologies through its 2020 Cities [DOE, 2021a] and RadSecure 100 [DOE, 2021b] initiatives, which prioritize permanent risk reduction and radioactive source security enhancements in cities where the effects of radiological terrorism would be most acute. The DOE/NNSA also offers security enhancements for mobile sources used in well logging and industrial radiography and takes steps to further integrate local law enforcement into radiological theft response planning, training, and alarm monitoring services to facilitate a cohesive response to potential theft events. Additionally, the DOE/NNSA has implemented a cloud-based feature for the Sentry-Remote Monitoring System (Sentry-SECURE) [DOE, 2021c] that sends alarms and video from a radioactive source location directly to responders' mobile devices to provide real-time situational awareness of a security incident. The DOE/NNSA also provides incentives to facilities interested in replacing cesium (Cs)-137 irradiators with non-radioisotopic devices that are now available. This

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[4] Agreement States are States that have entered into formal agreements with the NRC, pursuant to Section 274 of the *Atomic Energy Act of 1954*, as amended (Public Law 83-703) (AEA), to regulate certain quantities of AEA material at facilities located within their borders [AEA, 1954]. Under the AEA, the NRC relinquishes portions of its regulatory authority to license and regulate byproduct materials (radioisotopes), source materials (uranium and thorium), and certain quantities of special nuclear materials (enriched uranium and plutonium) to Agreement States. There are currently 39 Agreement States.

[5] The NRC regulations in 10 CFR 37.11(a), "Specific exemptions," state: "The Commission may upon application of any interested person or on its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not endanger life or property or the common defense and security, and are otherwise in the public interest."

replacement initiative includes the safe removal and disposal of disused Cs-137 irradiators and payment of up to 50 percent towards the purchase price of new non-radioisotopic devices. Chapter 3, “Progress in the Area of Alternative Technologies,” contains additional discussion on replacement of radioactive source-based uses with alternative technologies. Furthermore, in addition to providing resources to combat the potential theft of radioactive sources, the DOE/NNSA provides extensive training on emergency management for radioactive source licensees throughout the United States. In partnering with multiple DOE/NNSA offices, licensees are trained on numerous security and emergency preparedness protocols and response operations.

A. Tracking and Licensing Support for the Radioactive Source Security Program

The Integrated Source Management Portfolio (ISMP) is a set of information technology tools that supports radioactive materials licensing and tracking activities. The following key systems comprise the ISMP:

- The National Source Tracking System (NSTS) is a secure computer system that provides accountability for risk-significant radioactive sources from the time they are manufactured or imported through the time of their disposal or export, or until they decay to below a Category 2 quantity.

  The NSTS contains details on over 75,000 individual sealed sources and records with more than 1,000 source transactions per week [NRC, 2020a]. The NRC continues to routinely share NSTS data with the Federal Bureau of Investigation (FBI) and the U.S. Department of Homeland Security (DHS) to enhance the Nation’s capability to respond to emergency events that affect risk-significant radioactive sources. The inventory of risk-significant radioactive sources continues to be maintained through NRC and Agreement State licensees’ reporting of source transactions to the NSTS in accordance with 10 CFR 20.2207, “Reports of transactions involving nationally tracked sources.” DOE and domestic licensees also continue to report Category 1 and 2 radioactive source transactions, including imports and exports. The NRC and Agreement States verify compliance with NSTS reporting requirements to ensure that the NSTS database correctly reflects risk-significant radioactive sources possessed by licensees.

- The Web-Based Licensing System (WBL) is an up-to-date repository of NRC and Agreement State licenses that authorize possession of Category 1 and 2 quantities of radioactive materials.

- The License Verification System (LVS) is used to confirm that only authorized licensees obtain radioactive materials in authorized amounts. The LVS performs automated verification checks using data that reside in the WBL and the NSTS.

The ISMP portfolio is modernizing the way regulators and licensees conduct routine operations in an efficient, secure, and safe manner. The COVID-19 pandemic highlighted the importance of having remote access to information through information technology systems that support the national radioactive source security program.

On December 21, 2021, the NRC issued Staff Requirements Memorandum (SRM)-SECY-17-0083, “Staff Requirements—SECY-17-0083—Re-Evaluation of Category 3

Source Security and Accountability in Response to SRM-COMJMB-16-0001" [NRC, 2021a], and approved the staff's recommendation to pursue rulemaking to amend 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 40, "Domestic Licensing of Source Material"; and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material." This rulemaking will address concerns related to individuals obtaining a valid license by using a fictitious company or by providing false information to alter a valid license to obtain more or different radioactive material than authorized, or to counterfeit a license to obtain radioactive materials illicitly. This concern was documented in the 2018 Task Force report [NRC, 2018] in response to a Government Accountability Office (GAO) radioactive material licensing audit and investigation.

B. Cybersecurity

Task Force agencies have made significant progress on coordinating strategies and preventing and mitigating cybersecurity risks for radioactive sources. In August 2019, the NRC issued Information Notice 2019-04, "Effective Cyber Security Practices to Protect Digital Assets of Byproduct Materials Licensees" [NRC, 2019a], to provide licensees with information on general cybersecurity practices to effectively protect digital assets. The NRC continues to maintain awareness of the cybersecurity threat environment for byproduct materials to determine whether further regulatory action is necessary.

The DOE/NNSA has taken several actions to address cyber-attack scenarios that could result in unauthorized access or theft of a radioactive source. Cybersecurity concerns include, for example, a cyber-attack that degrades a licensee's physical security systems, facilitating a physical attack that could result in theft of radioactive sources (cyber-physical blended attack); exploitation of sensitive digital assets to gain access to a site's network(s); and use of social engineering to exploit unwitting insiders to gain access to physical security systems and networks. The DOE/NNSA Office of Radiological Security (ORS) used the cyber-attack scenarios to identify procurement requirements when funding physical security enhancements at NRC and Agreement State licensees' facilities to adequately address the postulated blended cyber-physical attack threats. ORS also developed cybersecurity best practices and training for site security officers responsible for the security of radioactive material and vendors that install ORS-funded security enhancements. In addition, ORS completed a template to be considered when developing facility security plans, addressing how to identify, assess, and respond to potential cyber-attack scenarios. Lastly, ORS has taken actions to implement insider threat mitigation measures (e.g., two-person controls on the Sentry-Remote Monitoring System) to address cyber insider threats.

In May 2020, the DHS Cybersecurity and Infrastructure Security Agency (CISA) used the National Institute of Standards and Technology Cybersecurity Framework to update its "Nuclear Sector: Cybersecurity Framework Implementation Guidance" [DHS, 2020]. The guidance specifically addresses key elements of supply chain cybersecurity and has proven to be a valuable resource for nuclear sector partners in their development and maintenance of cybersecurity programs at nuclear facilities. The CISA continues to work with the nuclear sector by providing threat briefings and guidance on emerging topics of security interest. The CISA offers proactive services to Government and critical infrastructure clients to assess and improve cybersecurity posture, understand risk, and identify operational strengths and weaknesses through its Cyber Assessments Program.

As a result of the completion of these significant security initiatives and tasks, including cybersecurity considerations pursued by Task Force member agencies, 2014 Recommendation 1 is complete. Task Force member agencies will continue to coordinate cybersecurity strategies and actions as threats continue to evolve. Coordinating actions include sharing information on relevant cyber-attacks, evolving cyber threats, and related best practices and training materials, as well as coordination of outreach efforts with Federal and State partners and stakeholders. The Task Force will continue to report pertinent cybersecurity-related coordinating actions in future Task Force reports.

III. Transportation Security

Since 2018, several initiatives related to transportation security of radioactive sources have been completed or are well underway. The DOE/NNSA and the FBI continue to cosponsor a series of tabletop exercises titled "Isotope Crossroads," designed to promote interagency communication and situational understanding in support of secure transportation of radiological sources. The agencies have conducted 10 Isotope Crossroads exercises since 2018.

During the COVID-19 pandemic, the DOE/NNSA and the FBI expanded and modified the Isotope Crossroads program to provide a 2-hour, Web-based program titled "Radiant Response." Radiant Response brings together select regional organizations that include the FBI Weapons of Mass Destruction Coordinator, local law enforcement, emergency operations, radiological health, transportation agencies, the DHS and the NRC, as well as private motor carrier companies to participate in the virtual transportation security workshops. As of 2022, the DOE/NNSA and the FBI have hosted 17 Radiant Response exercises.

The DOE/NNSA conducted an assessment of U.S. radioactive source security during transport and, as a result, formed the Transportation Security Unified Stakeholder Group (TSUSG) [ORS, 2019]. The TSUSG brings together members of Federal and State agencies, private industry, carriers and forwarders, law enforcement, and related professional associations to identify and examine current and potential transportation security concerns and challenges and to develop new or modified approaches that will strengthen the security of radiological materials in transit within the United States. The TSUSG's goal is to provide a forum where stakeholders can discuss, establish, collect, and harmonize best practices for shippers, carriers, regulators, and law enforcement within existing regulatory frameworks, guidance documents, and standards.

The DOE/NNSA continues to research technical and nontechnical enhancements and methods that shippers and carriers can implement to improve the security posture for shipments. These approaches enhance detection and delay of unauthorized access and enhance response to an attempted theft or sabotage of radioactive sources as well as insider threat mitigation.

PREVENTING AND MITIGATING CYBERSECURITY VULNERABILITIES

In 2022, Task Force member agencies confirmed completion of 2014 Recommendation 1, which states the following:

"The Task Force recommends that U.S. Government agencies assess the adequacy of and coordinate strategies for preventing and mitigating cybersecurity vulnerabilities related to Category 1 and 2 radioactive sources."

Task Force member agencies have completed adequate assessments and improved cybersecurity information sharing between the Federal Government and the owners and operators of critical infrastructure, certain vital systems, and assets in the United States in collaboration with critical infrastructure stakeholders to reduce cyber risks.

Efforts have continued under the January 2015 memorandum of understanding (MOU) for the secure transport of radioactive material by the DHS, the NRC, and the U.S. Department of Transportation [NRC, 2015a]. This MOU established a framework for allowing the parties to coordinate, to the maximum extent practicable, their respective responsibilities and activities related to the secure transportation of radioactive materials within the United States and across U.S. borders. The MOU has resulted in enhanced communications and increased cooperation among its parties. Task Force agencies have funded advancements in the state of science in transport security through two remote monitoring systems. Specifically, the DOE funded the Argonne (ARG) National Laboratory's development, patent, and licensing of the ARG-US CommBox [DOE, 2021d] and Traveler remote monitoring systems [DOE, 2021e] for nuclear and radioactive materials stored in facilities and during transportation. Both systems underwent extensive field testing, demonstration, and applications at multiple DOE sites, as well as use in truck and rail shipments between DOE and DOE/NNSA sites and between commercial industry facilities.

IV. Import and Export Controls

The U.S. Government continues to promote the use of the IAEA "Guidance on the Import and Export of Radioactive Sources," issued in March 2005 [IAEA, 2005] and updated in May 2012 [IAEA, 2012] (Import/Export Guidance). The Import/Export Guidance provides the basis for improving the security of legitimate cross-border transfers of sources and preventing the diversion of materials potentially usable in a radiological dispersal device or radiation exposure device. The Import/Export Guidance is the only international export control framework for radioactive sources. The IAEA reported, as of September 15, 2021, that 123 IAEA Member States have notified the organization of their intentions to act in accordance with the Import/Export Guidance [IAEA, 2021], an increase of 10 Member States from 2018. The United States continues to assist partner countries in the development and maintenance of national radioactive source registries. Maintaining and creating a sealed source registry is critical to good import/export practices amongst countries. These efforts to improve accounting and control of radioactive sources have resulted in countries recovering abandoned or legacy radioactive sources.

V. End-of-Life Management

Further work is underway to ensure that strategies have been fully considered to optimize end-of-life management for risk-significant sources in the United States and abroad, regardless of the origin of the sources. The United States has participated in consultations with other IAEA Member States since October 2014 to draft the "Guidance on the Management of Disused Radioactive Sources" and has achieved consensus on its contents. The guidance is supplementary to the Code of Conduct. The United States was instrumental in finalizing the guidance, which the IAEA policy-making bodies endorsed in September 2017 [IAEA, 2018]. Although non-legally binding, the document provides IAEA Member States further guidance on the establishment of a national policy and strategy for the management of disused sources and the implementation of management options such as recycling and reuse, long-term storage pending disposal, and returning disused sources to a supplier. In a March 2020 letter to the IAEA Director General [U.S. Mission to International Organizations in Vienna (UNVIE), 2020], the U.S. Government made a political commitment to meet the intent of the guidance.

The U.S. Government continues to assist and cooperate bilaterally with partner countries as well as to support IAEA activities on matters related to the safe and secure use of radioactive sources. The United States also encourages other Member States to make political commitments in support of the Code of Conduct and its supplementary guidance during

international forums.[6] For example, Member States were engaged during the IAEA-convened annual Code of Conduct review meeting and the IAEA International Conferences on Nuclear Security, most recently held in 2020. Additionally, the United States uses the IAEA's formalized process for the periodic exchange of information and lessons learned, as appropriate, and encourages other Member States to do the same.

While the United States has adequate capabilities to manage disused sources, challenges remain. Chapter 2, "Status of the Recovery and Disposition of Radioactive Sealed Sources," discusses challenges with the recovery and disposition of radioactive sources and the importance of effective end-of-life management of radioactive sources. Task Force member agencies will continue to assess strategies for end-of-life management for risk-significant radioactive sources.[7] The member agencies will focus on the following areas:

- Addressing end-of-life management challenges through various initiatives such as IAEA technical and consultancy meetings, international conferences on radioactive waste management, and regional engagements with suppliers and non-governmental organizations.

- Continuing to support the IAEA's process to develop technical documents on the reuse and recycling of disused radioactive sources. These documents address disposition issues that may provide technical obstacles to suppliers accepting returns of disused radioactive sources.

- Addressing the lack of a disposition pathway for foreign-origin americium (Am)-241, plutonium (Pu)-238, and Pu-239.

- Supporting efforts to develop guidance on "return to supplier," and initiatives to identify and document good practices to facilitate these agreements for domestic and international users.

Due to continuing efforts in these areas, the Task Force has determined that 2006 Action 10-2 remains ongoing, and the Task Force will continue to proactively assess strategies for end-of-life management for risk-significant radioactive sources. These efforts will complement the actions described in Chapter 2.

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6 The IAEA reported, as of September 15, 2021, that 44 nations, including the United States, have made a political commitment to meet the intent of the Guidance on the Management of Disused Radioactive Sources regarding the establishment of a national policy and strategy for the management of disused sources, and on the implementation of management options such as recycling and reuse, long term storage pending disposal and return to a supplier [IAEA, 2021].

7 The 2006 Action 10-2, as noted in the 2021 Task Force Implementation Plan, has a subtask to "identify and assess new, innovative actions or strategies appropriate for end-of-life management of risk-significant radioactive sources within the U.S." [NRC, 2021b].

Chapter 2: Status of the Recovery and Disposition of Radioactive Sealed Sources

During this report cycle, Task Force member agencies continued to make progress in increasing commercial disposal options for most Class A, B, and C sealed sources and in addressing a lack of transportation and disposal options for sealed sources with the highest activity. However, while progress has been made on these issues, the U.S. Government, regional compacts, and States should continue to ensure the safe disposal of disused radioactive sources. The Task Force will continue to focus on end-of-life source management issues, including activities to facilitate permanent disposal of disused sealed sources.

I. Management and Disposal of Commercial Disused Sealed Sources[8]

Progress has been made in addressing the commercial sealed source management and disposal challenges identified in previous Task Force reports. Commercial disposal options for most sealed sources classified as Class A, B, or C low-level radioactive waste (LLRW) are available, and there has been progress in addressing the lack of transportation and disposal options for the highest activity sealed sources.

Pilot Disposals Using Concentration Averaging and Encapsulation Branch Technical Position Guidance

The NRC revised its "Concentration Averaging and Encapsulation Branch Technical Position, Revision 1" (CA BTP) in 2015 [NRC, 2015b] to incorporate risk-informed, performance-based regulatory practices for disposal of certain higher-activity discrete items, including sealed sources.[9] The DOE/NNSA partnered with the Conference of Radiation Control Program Directors (CRCPD) to complete two pilot disposals using the "alternative approaches for averaging" provisions in the revised CA BTP to dispose of sources as Class C LLRW. The first pilot disposal was completed in September 2017 at the U.S. Ecology commercial LLRW disposal facility in Washington State. In December 2019, the CRCPD completed a second pilot disposal of two large sources at the Waste Control Specialists facility in Texas, each containing Cs-137. One source contained approximately 128.5 curies (Ci) (4.75 terabecquerels (TBq)), and the other source contained 251 Ci (9.29 TBq) at disposal. These successful pilot disposals demonstrated the effective use of the alternative approaches in the CA BTP guidance and provide a pathway for commercial disposal of similar high-activity Cs-137 sources in the future.

The Task Force continues to evaluate the impact of the CA BTP guidance on disposal of high-activity sources to determine whether additional actions are warranted to promote increased awareness and further usage of the guidance. The DOE/NNSA and the NRC

8 The IAEA's Code of Conduct defines a disused sealed source as "a radioactive source that is no longer used, and is not intended to be used, for the practice for which an authorization has been granted." Disused sealed sources should not be confused with abandoned or "orphan" sources, which are sources identified by regulatory or other authorities for which there is no determinable responsible party. Challenges in orphan sources management often overlap with, but are not identical to, the challenges (and solutions) addressed in this chapter.

9 The revisions in the CA BTP include increasing generic radioactivity limits for certain radionuclides that apply to any LLRW disposal facility licensed under 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," or corresponding Agreement State regulations, as well as provisions that enable disposal of disused sealed sources above the generic limits when consistent with public health and safety.

conducted outreach in 2019 to regulatory officials in the States of Texas and Washington, as well as to operators of the commercial LLRW disposal facilities in those States, to obtain insights into implementing the CA BTP with respect to disposal of any Category 1 or 2 sources at those facilities. In addition, the DOE/NNSA sponsored a study by the Low-Level Radioactive Waste Forum Disused Sources Working Group (DSWG), completed in May 2021, on implementing the CA BTP guidance and ongoing disposal challenges for sealed sources [low-level radioactive waste facility (LLRWF), 2021]. The DSWG study included extensive outreach to a variety of stakeholders, including disposal facility operators, LLRW brokers, and LLRW processors. These outreach efforts found that while the CA BTP has improved the process for classifying sealed sources for disposal, the revised guidance has not resulted in a significant increase in the number of sources being disposed. The DSWG study also noted the following:

Figure 2-1: Disposal of an irradiator for the CA BTP pilot in an engineered control barrier at the U.S. Ecology LLRW facility

- Stakeholders generally agreed that the CA BTP has improved the LLRW classification process through added clarity, allowing for the use of larger disposal containers and providing for additional flexibility.

- Numerous obstacles to sealed source disposal remain, including high disposal costs, limited availability and high cost of Type B packaging[10], and inadequate planning for the full life-cycle costs associated with sealed sources.

The Task Force will continue to evaluate the impact of the CA BTP on disposal of high-activity sources and determine whether additional actions are warranted to promote increased awareness and further usage of the CA BTP. While the NRC does not recommend additional regulatory actions to promote the usage of the CA BTP, the DOE/NNSA continues to assess other activities to facilitate commercial disposal.

II. Ongoing Challenges in Commercial Sealed Source Management and Disposal

Expanding the Availability of Type B Packaging for Transportation

In addition to the progress made to further enhance disposal options for LLRW, significant progress has also occurred in the availability of Type B packaging for transportation for

[10] A “packaging” for radioactive material transportation is the receptacle and any other components or materials necessary for the receptacle to perform its containment function in conformance with applicable regulatory requirements. The assembly of components may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment also may be designated as part of the packaging. A “package” is the packaging together with its radioactive contents as presented for transport.

high-activity disused sources (usually Class B, C, or greater-than-Class-C (GTCC) LLRW). The DOE/NNSA has developed, and the NRC has certified, two new Type B packaging options, the 435-B and the 380-B. The first shipment of the 435-B occurred in March 2019, and the first shipment of the 380-B (see Figure 2-2) occurred in May 2021. As of April 1, 2022, the DOE/NNSA has recovered 60 sources (~38,700 Ci (~1432 TBq)) using the 435-B and 23 sources (~16,800 Ci (~622 TBq)) in the 380-B packaging. These new packaging options will enable shipment of most commercial devices containing high-activity cobalt (Co)-60 and Cs-137 sources. The 435-B packaging design has been transferred to a commercial entity to increase the availability of suitable packaging capable of recovering Category 1 and 2 quantities of radioactive material.

Additionally, the DOE is developing a new Type B packaging (9602) design for storage, transportation, and disposal of disused radiological sources. Type B 9602 packaging's stainless steel structural components are designed to provide long-term performance against corrosion during dry storage (more than 50 years); thus, it may be possible to transport the package directly to a disposal facility without repackaging. The design for the Type B 9602 packaging is to be tested, and Argonne National Laboratory is preparing a safety analysis report for packaging for the new Type B packaging design for the DOE's review in 2022.

Figure 2-2: DOE/NNSA 380-B Type B transportation packaging

With the completion of a second pilot disposal using the CA BTP guidance and the operation of new Type B packaging, the Task Force can document notable progress toward increasing the availability of disposal options for high-activity Class B and C LLRW sealed sources. Notwithstanding this progress, the Task Force has determined that 2010 Recommendation 4 remains ongoing.

Removal of Risk-Significant (Category 1 and 2) Sources

The DOE/NNSA, through the Off-Site Source Recovery Program (OSRP), continues to remove risk-significant sources that have the potential to present public health and safety or national security concerns, if uncontrolled.[11] The security requirements of 10 CFR 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" [NRC, 2014b]. Since 2001, to address these concerns, OSRP has recovered approximately 6,830 Category 1 and 2 sources across the United States. The OSRP recoveries are prioritized according to risk-reduction criteria developed in coordination with the NRC and Agreement State regulators. However, as viable commercial disposal options increase, the need for Government involvement to recover disused sources should diminish.

Sealed sources containing foreign-origin Am-241, Pu-238, and Pu-239 currently have no

[11] Through its OSRP, the DOE/NNSA removes risk-significant sources that are disused and unwanted, at the request of NRC and Agreement State licensees. These sources remain secured in storage under the control of licensees until they are transferred to the DOE/NNSA.

disposition pathway. The DOE/NNSA has the authority to recover sealed sources under OSRP; however, OSRP is unable to recover foreign-origin Am-241, Pu-238, and Pu-239 sources without an identified path to disposal. Since the publication of the 2018 Task Force report, the DOE/NNSA has continued to investigate disposal options for these sources.

Additionally, the CRCPD completed the "CRCPD Technical White Paper: Disposition of Foreign Origin Radioactive Material, Revision 1," issued in May 2021 [CRCPD, 2021] (CRCPD White Paper), which outlines the disposal issues and possible solutions for sources containing foreign-origin material. Options include maintaining the sources at licensee sites, returning the sources to the manufacturer, aggregating the sources at the State radiation control program facilities or commercial waste brokers, developing a GTCC disposal facility, and developing a legislative solution allowing for disposal of foreign-origin sources at a Federal disposal facility. Task Force member agencies are currently reviewing the options offered in the CRCPD White Paper. The Task Force has determined that 2010 Recommendation 5 will remain ongoing while these and other options for management of sources containing foreign-origin radioactive material are being investigated and pursued.

Disposal of Greater-Than-Class-C Low-Level Radioactive Waste

As noted above, advances have been made in the availability of commercial disposal pathways for sealed sources. Nonetheless, challenges remain. Many sealed source users have little incentive to dispose of their disused sources, preferring to store them potentially until facility decommissioning. Some risk-significant sealed sources commonly used in medicine and industry have no commercial disposal pathway. In particular, there are no established disposal options for sources that are classified as GTCC LLRW because of the absence of a geologic repository in the United States; on a case-by-case basis, the NRC can approve the disposal of GTCC waste at a site other than a geologic repository (such approval must be made at the Commission level) in accordance with 10 CFR Part 61.

The NRC issued a draft regulatory basis to support the development of a rulemaking for disposal of GTCC waste for public comment on July 22, 2019 (Volume 84 of the *Federal Register* (FR), page 35037 (84 FR 35037)) [NRC, 2019b]. The draft regulatory basis included the NRC staff's preliminary conclusion that most of the GTCC waste streams analyzed in the draft regulatory basis are potentially suitable for near-surface disposal. The NRC held a public webinar and a subsequent public meeting in Austin, Texas, following issuance of the draft regulatory basis to provide an overview of the document and to invite members of the public to submit written comments [NRC, 2019c].

The NRC is also amending its regulations in 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," which governs LLRW land disposal facilities. The NRC staff submitted a draft final 10 CFR Part 61 rule to the Commission in September 2016 in SECY-16-0106 [NRC, 2016a]. On September 8, 2017, the staff received direction from the Commission in SRM-SECY-16-0106, "Staff Requirements—SECY-16-0106—Final Rule: Low- Level Radioactive Waste Disposal (10 CFR Part 61) (RIN 3150-AI92)" [NRC, 2017], to substantively revise the draft final rule in several key areas. However, given that the 10 CFR Part 61 rulemaking and the proposed GTCC rulemaking are related, the staff provided the Commission with options and a recommendation for the path forward on both rulemakings on October 21, 2020, in SECY-20-0098, "Path Forward and Recommendations for Certain Low-Level Radioactive Waste Disposal Rulemakings" [NRC, 2020b]. On April 5, 2022, the Commission issued SRM-SECY-20-0098, which approved the NRC staff's recommendation to develop a new proposed rule that consolidates and integrates criteria for licensing the disposal of GTCC waste with the ongoing 10 CFR Part 61 rulemaking efforts [NRC 2022]. The Commission further approved the NRC staff's recommendation to allow for Agreement State

licensing of those GTCC waste streams that meet the regulatory requirements for near-surface disposal and do not present a hazard such that the NRC should retain disposal authority [NRC, 2022].

Additionally, in February 2016, the DOE issued DOE/Environmental Impact Statement (EIS)-0375, "Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste" (Final EIS) [DOE, 2016a]. The Final EIS included a preferred alternative for disposal at generic commercial facilities or at the Waste Isolation Pilot Plant in Carlsbad, NM. In November 2017, the DOE submitted the Report to Congress [DOE, 2017a], describing the alternatives considered in the Final EIS as required by Section 631(b)(1)(B) of the *Energy Policy Act of 2005* (EPAct) [EPAct, 2005]. In October 2018, the DOE also issued DOE/EA-2082, "Environmental Assessment for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste at Waste Control Specialists, Andrews County, Texas" [DOE, 2018].

While the Final EIS, Report to Congress, and environmental assessment do not constitute a final decision on GTCC LLRW disposal, their completion represents a major accomplishment toward establishing a disposal pathway for certain radioactive sources.[12] The Task Force has determined that 2006 Action 9-1 will remain open while the DOE awaits action by Congress on GTCC LLRW disposal in accordance with the EPAct. After action by Congress occurs, the DOE could issue a Record of Decision on disposal of GTCC LLRW and GTCC-like waste and close 2006 Action 9-1.

Financial Assurance for End-of-Life Management of Category 1 and 2 Sources

Promulgating financial assurance requirements that address disposal of Category 1 and 2 sources could encourage licensees to dispose of disused sources once they are no longer needed as funds for source disposal would have been previously set aside. The NRC staff, in 2016, completed a scoping study to determine whether additional financial planning requirements were needed for end-of-life management of byproduct material, particularly radioactive sealed sources (see SECY-16-0046, "Results of the Byproduct Material Financial Scoping Study," dated April 7, 2016 [NRC, 2016b]). Based on the results of the scoping study, the NRC staff recommended to the Commission in SECY-16-0115, "Rulemaking Plan on Financial Assurance for Disposition of Category 1 and 2 Byproduct Material Radioactive Sealed Sources," dated October 7, 2016 [NRC, 2016c], that requirements in 10 CFR 30.35, "Financial assurance and recordkeeping for decommissioning," be expanded to include all Category 1 and 2 byproduct material radioactive sealed sources tracked in the NSTS. On December 8, 2021, the Commission issued SRM-SECY-16-0115 [NRC, 2021c] and directed the NRC staff to proceed with the rulemaking. Accordingly, the NRC staff is initiating rulemaking activities to support expanded financial assurance requirements for these types of sealed sources.

[12] Background information about this effort, including the 2016 Final EIS, the 2017 Report to Congress, and the 2018 environmental assessment, can be found at https://www.energy.gov/em/waste-management/waste-and-materials-disposition-information/greater-class-c-low-level [DOE, 2016b].

Chapter 3: Progress in the Area of Alternative Technologies

During this report cycle, the Task Force member agencies have worked to research and assess the viability of alternative technologies, coordinated with industry to share best practices, and developed actionable strategies to support the transition to non-radioisotopic technologies in cases where those technologies meet users' technical, operational, and cost requirements.

I. Background

In the EPAct, Congress directed the Task Force to identify and recommend "appropriate regulations and incentives for the replacement of devices and processes" that use Category 1 and 2 sealed sources. The EPAct specified alternative technologies or replacement of existing radiation sources with those radiation sources that could pose a lower risk to public health and safety as options to achieve this mandate. The DHS/CISA published the "Non-Radioisotopic Alternative Technologies White Paper" in September 2019 [DHS, 2019]. The white paper evaluated the application-specific technical, operational, and cost requirements for existing radioisotopic and non-radioisotopic replacement technologies and devices. In 2021, the National Academy of Sciences (NAS) published a report on alternative technologies [NAS, 2021], and the GAO examined available and developing alternative technologies to certain applications that use radioactive materials and evaluated Federal efforts to support conversion to alternative technologies [GAO, 2021]. The Task Force conducted a review of the reports and their recommendations.

Research and Development for Alternative Technologies

The 2008 NAS report [NAS, 2008], mandated by the EPAct,[13] identified specific areas where research and development of alternative technologies for cesium chloride (CsCl) and other applications should be pursued. Since 2018, at least four comparison studies of gamma and x-ray irradiation for medical research [Jacob et al, 2018; Jacob et al, 2019; MacKenzie et al, 2020; and Murphy and Kamen, 2019] and two comparison studies of gamma and electron beam and x-ray irradiation for medical product sterilization have been published [Fifield et al 2021a and Fifield et al, 2021b]. In addition, at least five new models of x-ray irradiators have entered the commercial market as alternatives to gamma sources for various applications. However, technological, operational, and economic challenges with the adoption of alternative technologies remain. In June 2021, the NAS published "Radioactive Sources: Applications and Alternative Technologies" [NAS, 2021]. The report recommended prioritizing funding for research and development projects that aim to develop alternatives to the use of radioactive sources in applications for which there are currently no acceptable non-radioisotopic alternative technologies, supporting equivalency studies for alternative technologies, and initiating research on alternatives to CsCl for calibration applications. For example, the use of non-radioisotopic alternative technologies for well logging has proven to be particularly difficult given technical and operational needs, such as durability, small size, and correlation of historical data. These and other challenges are the focus of ongoing research and development

[13] The EPAct, section 170H e.(2)(A), called for the NAS to develop a comprehensive technical assessment of replacement options and policy approaches to guide future efforts.

efforts in both the public and private sectors. Table 3-1 summarizes current and potential alternative technology research and development projects, including identification of common devices, primary isotopes, and potential replacement technologies, along with primary replacement challenges. These challenges may impact all users of the application, such as in the well logging example, or a subset of the users of the application.

Table 3-1: Current and Potential Alternative Technology Research and Development Projects

Sector Application	Common Devices, Primary Isotopes	Potential Replacement Technology	Primary Replacement Challenges	Current/Potential Research and Development Projects
Medical. Blood irradiation	Self-shielded irradiators, Cs-137	Four U.S. Food and Drug Administration-approved x-ray alternatives; technology currently being implemented	User preference	Blood irradiator using flat panel x-ray sources, pathogen reduction technology
Medical, Industrial. Research irradiation	Self-shielded irradiators, Cs-137 and Co-60	X-ray replacement increasingly viable; technology currently being implemented	Technical requirements, user preference, and legacy data issues	Modular addressable research irradiator using flat-panel x-ray sources; technology comparison studies (i.e., study correlating historical data to x-ray technology)
Medical. Cancer treatment	Teletherapy and radiosurgery treatment machines, Co-60	Linear accelerators used for most applications	Technical requirements and user preference	Advanced accelerator structures and treatment systems to provide more precise dose delivery
Industrial. Medical device sterilization, food irradiation. phytosanitary irradiation	Panoramic irradiators, Co-60	Electron beam and x-ray facilities available	Technical requirements, regulatory requirements, operational requirements, and high replacement cost	Efficient, high-power accelerator systems; studies of the impact of different radiation modalities on commonly sterilized materials; other technology comparison studies
Industrial. Energy exploration, well logging	Neutron and gamma-ray well logging devices, Am-241/ beryllium (Be) and Cs-137	Deuterium-based neutron generators, acoustic and magnetic resonance technologies	Technical requirements, including measurement capabilities, durability requirements, size constraints, and legacy data issues	Dense plasma focuses and deuterium-based neutron generators; compact electronic x-ray source (study correlating historical Am/Be data to the data provided by the potential replacement devices); nuclear magnetic resonance technology
Industrial. Nondestructive inspection/evaluation; quality assurance; defect analysis	Radiography and fixed industrial gauges, Co-60, Cs-137, iridium (Ir)-192, and selenium-75	X-ray, acoustic, magnetic, or eddy current technologies are widely used in less challenging environments	Technical and operational requirements in challenging environments	Advanced betatron for x-ray generation; wider application of x-ray and ultrasonic technologies may require further miniaturization of these devices
Agricultural. Pest control	Self-shielded irradiators, Cs-137, Co-60	X-ray and electron beam irradiators	Technical and operational requirements, and limited market size dissuade research and development	Ongoing x-ray and electron beam research and development to demonstrate technology readiness

The Task Force member agencies plan to take specific actions with respect to 2010 Recommendation 9 in the coming years to enhance support of short- and long-term research and development for alternative technologies. For example, the DOE/NNSA will conduct additional research, development, and testing during fiscal years 2022 and 2023 to advance the development of alternative technologies. The DOE/NNSA will also perform analyses to identify the remaining technological gaps that prevent the adoption of alternative technologies in specific applications, as appropriate (e.g., well logging and industrial sterilization). Because efforts are underway to research alternative technologies and address challenges impeding the use of alternative technologies in specific applications, the Task Force determined that 2010 Recommendation 9 will remain ongoing.

II. Transition to Alternative Technologies

While the development of alternative technologies has been a priority for several years, in 2014, the Task Force acknowledged the need to support users in transitioning from radioisotopic-based technologies to alternative technologies where viable options exist. In 2015, the White House National Science and Technology Council created the Interagency Working Group on Alternatives to High-Activity Radioactive Sources (GARS) as a first step in addressing the Task Force recommendation for Federal agencies to lead by example in consideration and adoption of alternative technologies. Federal efforts to replace Category 1 and 2 radioactive sources with effective alternatives have become increasingly successful for blood and research irradiation, in large part due to technological advances that have improved the reliability and cost of x-ray irradiation devices.

During this report cycle, the DOE/NNSA Cesium Irradiator Replacement Project (CIRP)[14] has replaced 229 Cs-137 blood and research irradiators, with more than 170 additional replacements in process. In total, this is 47 percent of the U.S. Cs-137 irradiator inventory replaced or in process of being replaced under the CIRP program. Recognizing the initial success of the CIRP program, the John S. McCain National Defense Authorization Act for Fiscal Year 2019 [115th Congress Public Law 232] specified a goal of eliminating the use of blood irradiation devices in the United States that rely on CsCl by December 31, 2027, through a voluntary program. The CIRP program is on track to replace all Cs blood irradiators among receptive users by the end of 2027.

To advance communications related to alternative technologies and the Task Force work, DHS/CISA initiated the Alternative Technologies Working Group (ATWG), a public-private stakeholder engagement, to inform stakeholders about the potential for replacement of radioactive sources with alternative technologies, including the identification of both technical and nontechnical challenges related to the various applications. The ATWG had more than 120 members and subject matter experts from over 40 entities in government, academia, and

[14] CIRP is voluntary, and program participants are responsible for selecting the non-radioisotope replacement device that meets their technical, operational, and financial requirements. CIRP support includes removal and disposal of the CsCl irradiator. Costs related to new device training, as well as the purchase of a warranty or maintenance agreement for the new device, are the responsibility of the program participants. To help ensure that program participation supports permanent risk reduction, CIRP participants sign a disposition agreement acknowledging the purpose and goal of the project. In addition, disbursement of financial incentives to CIRP participants takes place only after the removal of the CsCl device is complete [DOE, 2017b].

private industry.[15] The findings of the ATWG were documented in the "Non-Radioisotopic Alternative Technologies White Paper" [DHS, 2019], which identified and examined eight broad applications that currently use Category 1 and 2 quantities of Co-60, Cs-137, Ir-192, and Am-241. These include blood irradiators, research irradiators, radiotherapy, industrial sterilization, phytosanitary irradiation, sterile insect technique, well logging, and radiography. The white paper evaluated the application-specific technical, operational, and cost requirements for existing radioisotopic and non-radioisotopic replacement technologies and devices. Further, the white paper assessed application-specific approaches that may be effective in supporting technology transitions when users deem appropriate.

The Task Force agreed that an inclusive partnership among Federal and State agencies, manufacturers, industry, end users, standard-setting bodies, and technical consultants is important for the evaluation, demonstration, regulation, and promotion of innovative alternative technologies. Thus, Task Force member agencies will continue to pursue initiatives to share information related to alternative technologies with private and public partners, within each organization's statutory roles and responsibilities. These efforts may include educational workshops to facilitate common understanding of alternative technologies, along with the development of a publicly available online repository of information on alternative technologies (e.g., capabilities and limitations) across applications. The Task Force has determined that 2014 Recommendation 3 will remain ongoing as the DOE/NNSA continues to proactively close information gaps related to the capabilities and considerations for alternative technologies and incentivize their deployment, with the assistance of other Task Force member agencies. Further, Task Force member agencies have efforts underway to (1) ensure full consideration of alternative technologies in their agency activities and (2) facilitate broad awareness and information sharing related to alternative technologies. To facilitate interagency information sharing, the DOE/NNSA and the National Institutes of Health will continue to co-chair GARS.

U.S. Senate Report 116-102, "Energy and Water Development Appropriations Bill, 2020," dated September 12, 2019 [U.S. Senate, 2019], included a provision for the GAO to review alternative technologies for applications that use radioactive materials. After its review of alternative technologies, the GAO, in October 2021, published the report, "Alternatives to Radioactive Materials: A National Strategy to Support Alternative Technologies May Reduce Risks of a Dirty Bomb" [GAO, 2021]. The GAO examined: (1) the potential for adopting alternative technologies in the United States for medical and industrial applications, (2) factors affecting adoption of alternative technologies, and (3) Federal activities relating to alternative technologies in the United States. The report recommends that Congress "consider directing an entity to develop a national strategy to support alternative technologies."

Task Force member agencies have made considerable progress in evaluating the capabilities of, and challenges remaining for, successful use of alternative technologies. Where viable alternatives to radioisotopic applications exist, Task Force member agencies have advanced their use to provide permanent risk reduction in the interest of enhancing national security. The NAS and the GAO each published a report on Federal efforts to support alternative technologies in 2021 [NAS, 2021, GAO, 2021]. The Task Force reviewed these reports and factored the information into this Task Force report and recommendations. The Task Force agencies, consistent with each organization's statutory roles and responsibilities, will continue

[15] The DHS's Critical Infrastructure Partnership Advisory Council (CIPAC) framework facilitates consultation between the Federal Government and the appropriate private sector entities on subjects related to critical infrastructure protection and resilience. The ATWG falls under the CIPAC framework to form a private-public sector stakeholder engagement addressing alternative technologies [DHS, 2018].

to focus on encouraging the adoption of replacement technologies that meet technical, operational, and cost requirements. Federal agencies procuring Category 1 and 2 sealed sources and devices can document their assessments of the continued use of radioisotopic devices in comparison with available non-radioisotopic alternatives. Both the development and sharing of this information may help purchasers become familiar with replacement opportunities, trends, and decision factors and could also be used to assess overall progress in conversion efforts.

2022 Task Force Report Conclusion

Consistent with the EPAct, the Task Force has continued its efforts to evaluate the security of radioactive sources in the United States from potential terrorist threats, including acts of sabotage, theft, or use of a radiation source in a radiological dispersal device or a radiation exposure device and make related recommendations[16] to the President and Congress. During this report cycle, the Task Force completed one of the seven recommendations and actions that remained open at the start of this reporting period. The Task Force continues to—

- *advance its efforts to complete the remaining six recommendations and actions*
- *focus on end-of-life management of risk-significant sources*
- *evaluate the capabilities of non-radioisotopic alternative technologies and advance their use as a radiological security strategy*

Based on its review, the Task Force has concluded that (1) there are no significant gaps in the area of radioactive source protection and security that are not already being addressed through interagency cooperation and actions, and (2) important ongoing activities to support source protection and security need to continue.

16 Appendix I to this report lists the recommendations from the 2006, 2010, and 2014 reports along with their current status as of publication of this report. The 2018 Task Force report did not identify any new recommendations. The Task Force maintains an implementation plan to monitor progress on existing recommendations and actions and to identify activities needed to complete each one. This plan is updated biennially and is available at the NRC's public Web page (https://www.nrc.gov/security/byproduct/task-force.html). The next update will be available in 2023.

Appendix I: Summary Table of Recommendations and Actions

Recommendation	Description	Status
2006 Action 9-1	"The DOE [U.S. Department of Energy] should continue its ongoing efforts to develop GTCC [greater-than-Class-C] LLRW [low-level radioactive waste] disposal capability."	**Ongoing**—The DOE is awaiting "action by Congress" on GTCC LLRW disposal. (Chapter 2, Subsection II, provides recent accomplishments.)
2006 Action 10-2	"The U.S. Government should encourage suppliers to provide arrangements for the return of disused sources and examine means to reduce regulatory impediments that currently make this option unavailable."	**Ongoing**—Task Force on Radiation Source Protection and Security (Task Force) members continue to proactively assess strategies for end-of-life management for risk-significant (Category 1 and 2) radioactive sources. (Chapter 1, Subsections II and V, provide recent accomplishments.)
2010 Recommendation 4	"The Task Force recommends that the U.S. Government, regional compacts, and States continue to evaluate disposal options for disused radioactive sources, including options for handling a potentially large number of disused cesium chloride sources that may be replaced once viable alternatives are available."	**Ongoing**—The NRC is undertaking a rulemaking to amend its regulations in 10 CFR Part 61 to facilitate the disposal of these sources. (Chapter 2, Subsection II, provides recent accomplishments.)
2010 Recommendation 5	"The Task Force recommends that Federal and State Governments investigate options such as providing short-term secured storage of sources recovered from U.S. owners that contain foreign-origin americium-241 [Am-241] radioactive material, so that these sources can be recovered now, and increase efforts to investigate options for disposal of these sources."	**Ongoing**—Options for secure storage of sources recovered from U.S. owners that contain foreign-origin Am-241 are continuing to be investigated. (Chapter 2, Subsection II provides recent accomplishments.)
2010 Recommendation 9	"The Task Force recommends that the U.S. Government enhance support of short-term and long-term research and development for alternative technologies."	**Ongoing**—Efforts are underway to research alternative technologies and address challenges impeding the use of alternative technologies in specific applications. (Chapter 3, Subsection II, provides recent accomplishments.)
2014 Recommendation 1	"The Task Force recommends that U.S. Government agencies assess the adequacy of and coordinate strategies for preventing and mitigating cybersecurity vulnerabilities related to Category 1 and 2 radioactive sources."	**Complete**—Task Force agencies completed significant initiatives for preventing and mitigating cybersecurity vulnerabilities related to Category 1 and 2 radioactive sources. (Chapter 1, Subsection II, B, provides recent accomplishments.)

2014 Recommendation 3	"The Task Force recommends that the U.S. Government, as appropriate,[17] investigate options such as voluntary, prioritized, incentivized, programs for the replacement of Category 1 and 2 radioactive sources with effective alternatives. The Task Force further recommends that U.S. Government agencies, where appropriate, lead by example in the consideration of and transition to alternative technologies that meet technical, operational, and cost requirements."	**Ongoing**—The DOE's NNSA continues its leadership to proactively research replacement technologies and to incentivize their deployment, with the assistance of other Task Force member agencies. (Chapter 3, Subsection II, provides recent accomplishments.)

[17] The NRC's statutory mandate precludes it from promoting one technology over another for non-safety or [non-] security reasons. The NRC would review, in accordance with its procedures, any new license application for new technologies.

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