



Testimony

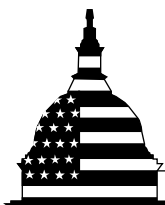
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U.S. Senate

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NUCLEAR NONPROLIFERATION

Further Actions Needed by U.S. Agencies to Secure Vulnerable Nuclear and Radiological Materials

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G A O

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Highlights of [GAO-12-512T](#), a testimony before the Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia, Committee on Homeland Security and Governmental Affairs, U.S. Senate

Why GAO Did This Study

In 2009, President Obama announced an international initiative to secure all vulnerable nuclear material worldwide within 4 years. Leaders of 47 nations endorsed this effort at the 2010 Nuclear Security Summit and will meet again in March 2012 to evaluate their work and set new goals for nuclear security. The United States has been a leader in promoting nuclear nonproliferation efforts worldwide. GAO has issued numerous reports on U.S. nonproliferation programs administered by several agencies, including the departments of Energy (DOE), State, and Defense (DOD); and the Nuclear Regulatory Commission (NRC). This testimony, which is based primarily on previously issued reports, discusses (1) the U.S. strategy to secure all vulnerable nuclear material within 4 years, (2) U.S. agencies' ability to track and evaluate the security of U.S. nuclear materials transferred to foreign countries, (3) challenges coordinating federal nuclear nonproliferation efforts, and (4) preliminary observations regarding GAO's ongoing work on federal efforts to secure radiological sources in U.S. hospitals and medical facilities. To conduct its ongoing work, GAO visited 25 hospitals and medical facilities in 7 states and the District of Columbia.

GAO is making no new recommendations, but continues to believe that implementation of the recommendations made in its recent reports complements and supports the administration's goal of securing vulnerable nuclear material in a timely fashion.

View [GAO-12-512T](#) or key components. For more information, contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

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What GAO Found

The President's 4-year initiative is a worthwhile effort designed to accelerate U.S. and international efforts to secure nuclear material worldwide. However, as GAO reported in December 2010, the governmentwide strategy approved by the National Security Council (NSC) for the initiative lacked specific details regarding how the initiative will be implemented. As a result, key details associated with the initiative are unclear, including its overall estimated cost, time frame for completion of work, and scope of planned work. In its 2010 report, GAO recommended, among other things, that NSC lead the interagency development of a more detailed implementation plan for the President's 4-year initiative. NSC did not comment on GAO's recommendations.

The United States also faces challenges accounting for and evaluating the security of U.S. nuclear material overseas. As GAO reported in September 2011, federal agencies are not able to fully account for U.S. nuclear material overseas that is subject to nuclear cooperation agreements. GAO also found that the agreements do not contain specific access rights that enable agencies to monitor and evaluate the physical security of U.S. nuclear material overseas. GAO found that the agencies responsible for reviewing foreign partners' security are not doing so systematically. GAO suggested that Congress consider directing DOE and NRC to fully account for U.S. weapon-usable nuclear materials overseas and consider amending the Atomic Energy Act to require access rights allowing the United States to verify adequate protection of U.S. nuclear materials if future agreements cannot be negotiated to include such rights.

GAO also reported in December 2011 on the challenges in coordinating U.S. governmentwide nonproliferation efforts. Specifically, GAO identified potential fragmentation and overlap among some U.S. programs that played a role in preventing and detecting the smuggling of nuclear materials overseas. GAO also found that no single federal agency had the lead responsibility to direct these efforts. GAO recommended, among other things, that NSC review U.S. programs working to prevent nuclear smuggling overseas to reduce fragmentation and potential overlap. NSC declined to comment on the recommendations.

In addition to nuclear materials, the Summit plans to address the security of radiological sources—material that could be used to make a dirty bomb. Based on preliminary results from ongoing work on federal efforts to secure radiological sources in U.S. hospitals and medical facilities, GAO found that NRC's security controls for hospitals and medical facilities do not prescribe the specific steps that must be taken to protect their radiological sources. GAO also found that medical facilities have implemented the controls in various ways. This has created a mix of security measures at the locations GAO visited that could leave some facilities more vulnerable than others. DOE's National Nuclear Security Administration (NNSA) has established a voluntary program to upgrade the security of domestic facilities that have radiological sources. NNSA has made progress in securing domestic radiological sources, but some facilities have declined NNSA's assistance, including hospitals located in high-risk urban areas.

Chairman Akaka, Ranking Member Johnson, and Members of the Subcommittee:

I am pleased to participate in this hearing in advance of the Nuclear Security Summit in South Korea. As you know, in 2009, President Obama announced an international initiative to secure all vulnerable nuclear materials around the world within 4 years, and leaders of 47 nations endorsed this initiative at the 2010 Nuclear Security Summit here in Washington. The leaders pledged to work together toward this end and also reaffirmed the fundamental responsibility of nations to maintain effective security of the nuclear materials and facilities under their control. At the conclusion of the summit, the leaders agreed to meet again in South Korea in March 2012 to evaluate their work and set new goals for nuclear security, including the security of radiological material. We recognize the importance of the Summit as a way to galvanize international support for reducing the risks posed by the proliferation of these dangerous materials and are pleased to see that radiological material security will be given greater attention. This could provide a more comprehensive and balanced approach to risk reduction efforts by the international community.

One of the most serious threats facing the United States and other countries is the possibility that other nations or terrorist organizations could steal a nuclear warhead or nuclear weapon-usable materials from poorly secured stockpiles around the world,¹ or that nations could divert nuclear material intended for peaceful purposes to the development of nuclear weapons. Terrorists or countries seeking nuclear weapons could use as little as 25 kilograms (Kg) of weapon-grade highly enriched uranium (HEU) or 8 Kg of plutonium to construct a nuclear weapon. Of great concern is that terrorists could fashion a crude nuclear bomb made from either HEU or plutonium into an improvised nuclear device (IND). An IND would create an explosion producing extreme heat, powerful shockwaves and intense radiation that would be immediately lethal to individuals within miles of the explosion, as well as radioactive fallout over thousands of square miles. Nonproliferation experts estimate that a successful IND could produce the same force as the equivalent yield of the bomb that destroyed Nagasaki, Japan, in 1945; it could devastate the

¹Weapon-usable nuclear materials are highly enriched uranium, uranium-233, and any plutonium containing less than 80 percent of the isotope plutonium-238. Such materials are also often referred to as fissile materials or strategic special nuclear materials.

heart of a medium-sized U.S. city. The explosion could cause hundreds of thousands of deaths and injuries, as well as pose long-term cancer risks to those exposed to the radioactive fallout.

Radiological material also poses a significant security threat to the United States and the international community. Radiological material, such as cobalt-60, cesium-137, and strontium-90, is encapsulated or sealed in metal—such as stainless steel, titanium, or platinum—to prevent its dispersal and is commonly called a sealed radiological source. Sealed radiological sources are used worldwide for many legitimate purposes, such as medical, industrial, and agricultural applications. The total number of these sources in use worldwide is unknown because many countries do not systematically account for them. If certain types of these sources were obtained by terrorists, they could be used to produce a simple and crude but potentially dangerous weapon—known as a radiological dispersion device, or dirty bomb. Although experts believe that a dirty bomb could result in a limited number of deaths, it could have severe economic consequences. Depending on the type, amount, and form, the dispersed radiological material could cause radiation sickness for people nearby and produce serious economic, psychological and social disruption associated with the evacuation and subsequent cleanup of the contaminated area. The economic consequences resulting from the improper use of radiological materials is not theoretical. Some actual incidents involving sources can provide a measure of understanding of what could happen in the case of a dirty bomb attack. For example, in 1987, an accident involving a medical device containing about 1,400 curies of cesium-137,² killed four people in Brazil's Goiania region and injured many more. The accident and its aftermath caused about \$36 million in damages to the region. The decontamination process required the demolition of homes and other buildings and generated 3,500 cubic meters of radioactive waste.

To address these threats, respond to the President's goal of securing vulnerable nuclear material worldwide within 4 years, and meet the objectives of the Nuclear Security Summit, U.S. agencies have undertaken a number of nuclear nonproliferation efforts. Specifically, the

²A curie is a unit of measurement of radioactivity. In modern nuclear physics, it is defined as the amount of substance in which 37 billion atoms per second undergo radiological disintegration. In the international system of units, the becquerel is the preferred unit of radioactivity. One curie equals 3.7×10^{10} becquerels.

National Nuclear Security Administration (NNSA), a separately organized agency within the Department of Energy (DOE) has more than 20 programs that are intended to, among other things, secure nuclear warheads; reduce the risk of nuclear smuggling; and protect, consolidate, and dispose of weapon-usable nuclear material and radiological sources. The two other U.S. agencies that conduct major nuclear nonproliferation programs and activities overseas are the departments of Defense (DOD) and State. DOD administers the Cooperative Threat Reduction program, which has facilitated the removal of nuclear weapons from Ukraine, Belarus, and Kazakhstan and has helped Russia and Ukraine meet their arms control commitments by assisting in the elimination of strategic delivery systems. State manages its own nonproliferation programs, such as the Export Control and Related Border Security program,³ provides support to NNSA and other U.S. agencies' nuclear nonproliferation programs working overseas, and conducts bilateral and multilateral diplomacy to address proliferation threats around the world under its Bureau of International Security and Nonproliferation. The Department of Homeland Security is responsible for, among other things, developing and deploying technologies to detect, prevent and interdict nuclear materials smuggled into the United States. National Security Council (NSC) staff have the principal role in coordinating the implementation of NNSA, DOD, State, and other agencies' nonproliferation programs. NSC oversees development of general policy and establishes guidelines for U.S. nonproliferation programs, but it does not implement programs or control their budgets. In addition, the Nuclear Regulatory Commission (NRC) and NNSA are involved in regulating and/or securing radiological sources within the United States and in foreign countries.

My statement today is based primarily on reports we issued from September 2010 to December 2011 that assess various U.S. nuclear nonproliferation programs and activities that support both the President's 4-year initiative and, more broadly, the goals of the Summit. Specifically, I will focus my testimony on (1) the U.S. governmentwide strategy for supporting the President's goal of securing all vulnerable nuclear materials worldwide within 4 years, (2) U.S. agencies' ability to track and

³The Export Control and Related Border Security program seeks to prevent the proliferation of weapons of mass destruction and advanced conventional weapons by helping to build effective national export control systems in countries that possess, produce, or supply strategic items as well as in countries through which such items are most likely to transit.

evaluate the security of U.S. nuclear materials transferred to foreign countries, (3) challenges in coordinating federal nuclear nonproliferation efforts, and (4) ongoing work on federal efforts to secure radiological sources in U.S. hospitals and medical facilities. Detailed information on our scope and methodology for our prior work can be found in these reports. To develop our preliminary observations on efforts to secure radiological sources in U.S. medical facilities, we visited 25 hospitals and medical facilities in seven states and the District of Columbia, interviewed regulatory officials from 20 states, and interviewed agency officials at DOD, DOE, NRC, and the Department of Veterans Affairs (VA).⁴ We also reviewed relevant laws, regulations, and guidance for overseeing commercial radiological sources. We are conducting our ongoing work 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.

We obtained the views of DOE, DOD, VA and NRC for new information in our statement concerning radiological source security at U.S. hospitals and medical facilities. We incorporated the agencies' technical comments where appropriate.

Background

The 2010 Nuclear Security Summit highlighted the global threat posed by nuclear terrorism and the need for countries to work in a comprehensive and concerted fashion to ensure that nuclear materials are not stolen or diverted for weapons use. The Summit produced a communiqué, a high-level political statement by the leaders of the 47 participating countries. The communiqué identified several measures that countries planned to take to strengthen their nonproliferation efforts. These efforts included, among other things, (1) focusing on improving security; (2) accounting for and consolidating HEU and plutonium; and (3) ensuring that the

⁴We conducted site visits at hospitals and medical facilities in California, Maryland, New York, Pennsylvania, Tennessee, Texas, Virginia, and the District of Columbia. We also interviewed regulatory officials from Alabama, Arizona, Arkansas, California, Colorado, Florida, Kentucky, Maryland, Massachusetts, Mississippi, New Mexico, New York, North Carolina, Pennsylvania, Rhode Island, Tennessee, Texas, Virginia, Washington, and Wisconsin.

International Atomic Energy Agency (IAEA) has the necessary resources to carry out its nuclear security activities.⁵

The 2010 Summit produced results. For example, Ukraine announced at the Summit that it would ship approximately 236 pounds of HEU and 123 pounds of spent nuclear fuel to Russia by the end of 2012.⁶ During the Summit, the United States, Canada, and Mexico announced a new agreement that calls for the conversion of HEU fuel at Mexico's nuclear research reactor to low enriched uranium. Malaysia, Egypt, and Armenia planned to enact new export control laws to limit nuclear trafficking. Malaysia, an important hub in the A.Q. Khan illicit nuclear trafficking network, approved a new export law curbing transfers of nuclear weapons-related materials. Many other nations expressed their support to funding efforts for international nuclear safety organizations. For example, Belgium, Japan, the United Kingdom, Norway, and New Zealand all pledged funding efforts towards IAEA's Nuclear Security Fund.⁷

⁵The International Atomic Energy Agency is an independent organization based in Vienna, Austria, that is affiliated with the United Nations and has the dual mission of promoting the peaceful uses of nuclear energy and verifying that nuclear technologies and materials intended for peaceful purposes are not diverted to weapons development efforts. As of February 2012, the agency had 153 member states. We have recently begun a review of IAEA programs and activities at the request of this subcommittee.

⁶In February 2012, NNSA officials told us that the Summit process has accelerated U.S. efforts to remove HEU from several countries. Specifically, since the 2010 Summit, NNSA has worked with international partners to remove 380 Kg of HEU from civilian sites in seven countries: Belarus, the Czech Republic, Kazakhstan, Poland, Serbia, South Africa, and Ukraine.

⁷IAEA's Nuclear Security Fund supports the agency's efforts to assist countries in protecting their nuclear and radiological materials and facilities. For more information, see GAO, *Nuclear Nonproliferation: IAEA Has Strengthened Its Safeguards and Nuclear Security Programs, but Weaknesses Need to Be Addressed*, [GAO-06-93](#) (Washington, D.C.: Oct. 7, 2005).

Governmentwide Strategy to Implement the President's 4-Year Global Nuclear Material Security Initiative Lacked Important Details

In December 2010, we reported on aspects of U.S. planning and strategies to secure all vulnerable nuclear materials worldwide within a 4-year period.⁸ Following President Obama's announcement of the 4-year initiative, NSC took the lead in coordinating efforts among different federal agencies that will contribute to the initiative. NSC officials approved a U.S. governmentwide strategy entitled "Interagency Efforts to Improve the Security of Nuclear Weapons and Fissile Materials," which, among other things, described the scope and objectives of the interagency effort and identified the main activities by agencies and programs in support of the President's initiative. U.S. agencies—including NNSA, DOD, and State—had identified individual plans describing how they intend to contribute to the 4-year initiative. NNSA, for example, had developed a formal written plan with specific details regarding how it intends to contribute to the 4-year nuclear material security goal. The NNSA plan details a prioritized five-part effort, including (1) continuing nuclear security cooperation, especially nuclear material protection, control and accounting (MPC&A) upgrades and efforts to transition responsibility for sustaining MPC&A systems;⁹ (2) expanding nuclear security cooperation with other countries; (3) accelerating nuclear material removal with other countries; (4) strengthening nuclear security standards, practices, and next-generation nuclear safeguards; and (5) building international capabilities to prevent illicit nuclear trafficking and smuggling.

Despite individual agency efforts to implement the 4-year initiative, we found that the overarching interagency strategy coordinated by NSC lacked specific details concerning how the initiative would be implemented, including the identity of, and details regarding, vulnerable foreign nuclear material sites and facilities to be addressed, agencies and programs responsible for addressing each site, planned activities at each site, potential challenges and strategies for overcoming these challenges, anticipated timelines, and cost estimates. NSC officials told us that developing a single, integrated cross-agency plan that incorporates all these elements could take years. However, we found that, absent such

⁸GAO, *Nuclear Nonproliferation: Comprehensive U.S. Planning and Better Foreign Cooperation Needed to Secure Vulnerable Nuclear Materials Worldwide*, [GAO-11-227](#) (Washington, D.C.: Dec. 15, 2010).

⁹NNSA's MPC&A program works to improve the security of nuclear warheads and materials in Russia and at nuclear sites in other countries, consolidate and convert weapon-usable nuclear material stocks, and enable Russia and other countries to sustain MPC&A upgrades over the long term without continued U.S. support.

an implementation plan, essential details associated with the 4-year initiative were unclear, including the initiative's overall estimated costs, time frames, and scope of work. For instance, we reported that the costs of implementing the initiative were unknown. Among other things, NSC officials told us that estimating the costs associated with the President's goal is impossible because the initiative is predicated on having other countries provide assistance and share costs, and it is impossible to forecast cooperation that may occur with other countries, including the resumption of denuclearization efforts in North Korea.

We also found that the time frames for the initiative are uncertain because NSC officials did not consider the 4-year time frame to be a hard and fast deadline. Rather than achieving a specific level of nuclear material security around the world within the 4-year time frame, the President's proposal has value in broader terms, according to NSC officials. They described the value of the President's proposal as a "forcing function" to (1) accelerate ongoing U.S. nuclear nonproliferation programs, (2) drive closer integration of nuclear nonproliferation programs across the federal government, and (3) mobilize greater international responsibility for and commitment to nuclear material security. Furthermore, we reported that other details relating to the overall scope of the 4-year initiative were vague. For example, we were unable to identify the scope of nuclear material worldwide that would be addressed under the initiative, because such details were not included in the interagency strategy document. We also identified concerns with how the initiative intends to address sites with potentially vulnerable nuclear materials located in countries that may impose access limitations that could complicate or preclude U.S. security assistance.

We recommended that NSC lead and coordinate the development of a comprehensive plan for implementing this initiative. Such a plan, in our view, should clearly identify the specific foreign countries, sites, and facilities, where materials have been determined to be poorly secured, and include information specifying the agencies and programs responsible for addressing each location; planned activities, potential implementation challenges, and steps needed to overcome those challenges at each location; and estimated time frames and costs associated with achieving the 4-year goal. NSC did not comment on our recommendation.

U.S. Agencies Have Limited Ability to Account for, Monitor, and Evaluate the Security of U.S. Nuclear Material Overseas

Improving the U.S. government's management of nuclear cooperation agreements could contribute to the administration achieving its goal of securing all vulnerable nuclear material worldwide in 4 years.¹⁰ The United States has exported special nuclear material, including enriched uranium, and source material such as natural uranium under these framework agreements for many years. These agreements must contain certain obligations that govern, among other things, the U.S. rights of approval over the transfer, retransfer, enrichment, and reprocessing of certain kinds of nuclear materials transferred from the United States and, in some cases, produced overseas. Partners are required to guarantee the physical protection of U.S. nuclear materials. In September 2011, we issued a report that (1) assessed U.S. agency efforts to account for U.S. nuclear material overseas, (2) assessed DOE and U.S. agencies' efforts to evaluate the security of these materials, and (3) described DOE's activities to secure or remove potentially vulnerable U.S. nuclear material at partner facilities.¹¹

We found that U.S. agencies—DOE, NRC, and State—are not able to fully account for U.S. nuclear material overseas that is subject to the terms of nuclear cooperation agreements because (1) the agreements do not stipulate systematic reporting of such information, and (2) there is no policy to pursue or obtain such information. These agreements generally require that partners report inventory information upon request. However, the agencies have not systematically sought such information. Specifically, DOE and NRC do not have a comprehensive, detailed current inventory of U.S. nuclear material—including weapon-usable material—that is located overseas. In addition, NRC and DOE could not fully account for the location and disposition of U.S. HEU overseas in

¹⁰The United States has 27 nuclear cooperation agreements in force for peaceful civilian cooperation with partners, including foreign countries, the European Atomic Energy Community (EURATOM), IAEA, and Taiwan. Governmental relations between the United States and Taiwan were terminated on January 1, 1979. All agreements concluded with the authorities on Taiwan prior to January 1, 1979, are administered for the United States by the American Institute in Taiwan, a nonprofit corporation based in Washington, D.C. The United States has two nuclear cooperation agreements with Australia, including one for Separation of Uranium Isotopes by Laser Excitation technology, bringing the total number of agreements to 27.

¹¹GAO, *Nuclear Nonproliferation: U.S. Agencies Have Limited Ability to Account for, Monitor, and Evaluate the Security of U.S. Nuclear Material Overseas*, [GAO-11-920](#) (Washington, D.C.: Sept. 8, 2011).

response to a 1992 congressional mandate.¹² The January 1993 report that NRC produced in response to the mandate stated that it was not possible to reconcile this information from available U.S. sources of data with all foreign holders of U.S. HEU within the 90-day period specified in the act. Our analysis of other documentation associated with the report shows that NRC, in consultation with U.S. agencies, was able to verify the location of 1,160 kilograms out of 17,500 kilograms of U.S. HEU remaining overseas as of January 1993. According to DOE and NRC officials, no further update to the 1993 report was issued, and the U.S. government has not subsequently attempted to develop such a comprehensive estimate of the location and status of U.S. HEU overseas.

Nuclear cooperation agreements do not contain specific access rights that enable U.S. agencies to monitor and evaluate the physical security of U.S. nuclear material overseas, and the United States relies on its partners to maintain adequate security. In the absence of access rights, DOE, NRC, and State have conducted physical protection visits, when permitted, to monitor and evaluate physical security conditions of U.S. nuclear materials at overseas facilities. However, we found that the agencies have not systematically visited countries believed to be holding the most sensitive material or systematically revisited facilities not meeting international physical security standards in a timely manner. U.S. interagency teams made 55 visits from 1994 through 2010 and found that countries met IAEA security guidelines approximately half of the time.

There are several countries that have U.S. nuclear material that are particularly problematic and represent special cases for concern. Specifically, U.S. nuclear material has remained at sites in three countries where physical protection measures are unknown or the sites have not been visited by an interagency physical protection team in decades. DOE's Global Threat Reduction Initiative (GTRI) removed a large quantity of U.S.-spent HEU recently from one of those countries. However, according to NRC and State officials, U.S. transfers to these three countries were made prior to 1978, when a requirement that the partner countries guarantee that they will maintain adequate physical security for transferred nuclear material was added to the U.S. Atomic Energy Act of 1954. Therefore, these countries have not made the same commitments

¹²Energy Policy Act of 1992, Pub. L. No. 102-486, § 903(b), 106 Stat. 2776, 2945-46.

regarding the physical security of U.S.-transferred material as the United States' other nuclear cooperation agreement partner countries.

We also found that physical security concerns are not confined to countries that have limited infrastructure and resources. The potential vulnerability of nuclear material at certain facilities in high-income countries was raised to us by NSC officials.¹³ Specifically, we reported that there may be security vulnerabilities in certain high-income countries, including three specific high-income countries. For sites in these countries, GTRI officials told us the U.S. government's strategy is to work bilaterally with the countries, provide recommendations to improve physical protection, and follow up as needed.

In our September 2011 report, we found that DOE has taken steps to improve security at a number of facilities overseas that hold U.S. nuclear material but faces constraints. DOE's GTRI program removes U.S. material from vulnerable facilities but can only repatriate materials that have an approved disposition pathway and meet the program's eligibility criteria. GTRI officials told us that of the approximately 17,500 kilograms of HEU exported from the United States, 12,400 kilograms are currently not eligible for return to the United States. The vast majority of this amount—about 10,000 kilograms—is currently not eligible for return because the material does not have an acceptable disposition pathway, such as permanent disposal or potential reuse. Another 2,000 kilograms of material is located primarily in the European Atomic Energy Community (EURATOM) member countries and is in use or adequately protected, according to GTRI officials.¹⁴

As a result, we made several suggestions and recommendations to improve oversight and accountability. For example, we suggested that Congress consider directing DOE and NRC to compile an inventory of U.S. weapon-usable nuclear materials overseas. As a separate matter, we also suggested that Congress consider amending the Atomic Energy Act if State, working with other U.S. agencies, does not include enhanced measures regarding physical protection access rights in future and renewed agreements, so that U.S. interagency physical protection teams may obtain access when necessary to verify that U.S. nuclear materials

¹³[GAO-11-227](#).

¹⁴EURATOM is composed of the 27 countries of the European Union.

have adequate physical protection. We also recommended that the Secretary of State, working with the Secretary of Energy and the Chairman of the NRC, establish better inventory reporting and reconciliation procedures, particularly when it comes to foreign facilities holding U.S. weapon-usable material.

DOE, NRC, and State generally disagreed with our recommendations when commenting on our draft report, including the need to reconcile inventories with partner countries, stating that these reconciliations were unnecessary. State believes that implementing the recommendations, generally, would adversely impact U.S. commercial competitiveness in overseas markets and diminish U.S. influence to advance our nonproliferation objectives and cost jobs at home. DOE, however, now agrees in principle with several recommendations we directed to that agency according to a January 24, 2012, letter to us. For example, we recommended, among other things, that DOE, working with its interagency partners, develop formal goals and a systematic process to determine which foreign facilities to visit for future interagency physical protection visits. DOE informed us in the January 2012 letter that it is working with NRC, State, and other agencies to develop a new methodology and improve their efforts to set priorities for U.S. interagency physical protection visits. To that end, DOE has established regular interagency conference calls to coordinate upcoming visits and directed a national laboratory to establish a repository of information regarding past physical protection visits to assist in determining which sites to visit in the future and in what time frame to do so.

Agencies Face Challenges in Coordinating U.S. Efforts to Combat Nuclear Smuggling Overseas

Reducing the risks posed by vulnerable nuclear material worldwide requires a layered approach to protecting such material. As a first layer of defense, the United States has helped countries secure nuclear materials in place at civilian and defense facilities. As a second line of defense, the United States has also helped countries improve their border security to address the threat posed by nuclear smuggling. According to IAEA, there were 2,164 confirmed cases of illicit trafficking in nuclear and radiological materials worldwide from 1993 through 2011.

In December 2011, we reported on issues relating to the coordination of U.S. programs involved in combating nuclear smuggling overseas.¹⁵ We reviewed 21 federal programs and offices under five federal agencies—NNSA, DOD, State, DHS, and the Department of Justice. These programs (1) conduct research and development on radiation detection technologies, (2) deploy radiation detection equipment along foreign borders and points of transit, (3) train and equip foreign customs and border security officials to identify and interdict illicit nuclear materials or technology transfers, (4) assist foreign governments in the development of export control systems, (5) enhance and coordinate with foreign antismuggling law enforcement and prosecutorial capabilities, and (6) analyze potential foreign nuclear smuggling cases and incidents.

However, we found impediments to the coordination of U.S. efforts to combat nuclear smuggling overseas. Specifically, we found that none of the existing strategies and plans for coordinating federal efforts to prevent and detect nuclear smuggling and illicit nuclear transfers overseas incorporate all of the desirable characteristics of national strategies, such as identifying the financial resources needed and monitoring mechanisms to be used to determine progress and make improvements. For example, the 2010 Global Nuclear Detection Architecture Strategic Plan—developed jointly by DHS, DOD, Energy, State, Justice, the intelligence community, and NRC—did not identify the financial resources needed to achieve the strategic plan’s objectives or the monitoring mechanisms that could be used to determine programmatic progress and needed improvements.

We also identified potential fragmentation and overlapping functions among some programs. Specifically, we identified six programs that provide training to improve the capabilities of foreign border security and customs officials to prevent smuggling and illicit nuclear shipments: (1) NNSA’s Second Line of Defense program, (2) International Nonproliferation Export Control Program, and (3) Cooperative Border Security Program,¹⁶ (4) State’s Export Control and Related Border

¹⁵GAO, *Nuclear Nonproliferation: Action Needed to Address NNSA’s Program Management and Coordination Challenges*, [GAO-12-71](#) (Washington D.C.: Dec. 14, 2011).

¹⁶The Cooperative Border Security Program was an independent program at the time of our review on the coordination of federal programs involved in combating nuclear smuggling overseas. However, the program is no longer an independent program, and its functions were merged into the International Nonproliferation Export Control Program in June 2010.

Security program, (5) DOD's Weapons of Mass Destruction-Proliferation Prevention Program, and (6) International Counterproliferation Program. Similarly, we identified four programs that are involved in providing equipment to foreign governments to enhance the ability of their customs and border security organizations to detect nuclear smuggling: (1) NNSA's Second Line of Defense program, (2) State's Export Control and Related Border Security program, (3) DOD's Weapons of Mass Destruction-Proliferation Prevention Program, and (4) DOD's International Counterproliferation Program. In prior reports on nuclear nonproliferation programs, we have found that consolidating programs that share common goals and implement similar projects can maximize limited resources and may achieve potential cost savings or other programmatic and administrative efficiencies.

Agency officials representing these programs told us that not all of them have the same focus, that some concentrate on specialized niches, and that many are complementary. For instance, regarding the provision of equipment, NNSA, State, and DOD officials noted that the Second Line of Defense program tends to provide larger equipment, such as radiation portal monitors and cargo scanning equipment, while the Export Control and Related Border Security Program and International Counterproliferation Program provide smaller-scale equipment, such as hand-held radiation detection pagers, hazardous materials kits, and investigative suits to foreign customs and border security organizations. Nevertheless, in our view, the fragmented and overlapping nature of the programs raise questions as to whether greater efficiency could be obtained through possible consolidation of such efforts.

Furthermore, we found that no single federal agency has lead responsibility to direct federal efforts to prevent and detect nuclear smuggling overseas. In the past, we have reported that interagency undertakings can benefit from the leadership of a single entity with sufficient time, responsibility, authority, and resources needed to ensure that federal programs are based upon a coherent strategy and are well coordinated, and that gaps and duplication in capabilities are avoided.¹⁷ For instance, State and DOD officials told us that neither State nor any

¹⁷See GAO, *Combating Terrorism: Selected Challenges and Related Recommendations*, [GAO-01-822](#) (Washington, D.C.: Sept. 20, 2001); and *Biosurveillance: Efforts to Develop a National Biosurveillance Capability Need a National Strategy and Designated Leader*, [GAO-10-645](#) (Washington, D.C.: June 30, 2010).

other federal agency has the authority to direct the activities or coordinate the implementation of programs administered by other agencies involved in preventing or detecting nuclear smuggling overseas.

Regarding interagency coordinating mechanisms, NSC has established mechanisms to coordinate efforts in this area, including a Countering Nuclear Threats Interagency Policy Committee (IPC) and a sub-IPC for international nuclear and radiological border security efforts. NSC officials declined our request to discuss various aspects of the IPC structure and how it coordinates U.S. efforts to combat nuclear smuggling overseas. However, some officials from other agencies expressed doubts about the value of NSC's coordinating role. Notably, DOD officials told us that they believed NSC has played a negligible role in coordinating programs to counter nuclear smuggling.

We made two recommendations to NSC to streamline and eliminate the potential for fragmentation and overlap among U.S. government programs involved in preventing and detecting the smuggling of nuclear materials overseas. Specifically, we recommended that NSC undertake or direct an appropriate agency or agencies to conduct a comprehensive review of the structure, scope, and composition of agencies and programs across the federal government involved in such efforts. Such a review should include, among other things, (1) the level of overlap and duplication among agencies and programs and (2) potential for consolidation to fewer programs and agencies. Following this review, new guidance should be issued that incorporates the elements of effective strategic plans, including clearly delineating the roles and missions of relevant programs, specific priorities, performance measures, overall program costs, and projected time frames for program completion. NSC did not respond to these recommendations.

Agencies Have Taken Steps to Secure Domestic Radiological Materials, but Gaps Remain

In 2007, we issued a report at the Subcommittee's request focusing on the security of radiological sources overseas.¹⁸ In the course of that work we visited a number of hospitals and medical facilities in foreign countries and identified weaknesses in security. For example, in one country the security cable used to secure a teletherapy machine's cobalt-60 source had been broken for almost a month. In another country, we observed that a storage facility containing devices with thousands of curies of cesium-137 had several unsecured large openings in the roof. Based on the findings in this report, the Subcommittee subsequently asked us to review the security of hospitals and medical facilities in the United States that use radiological sources. Hospitals and medical facilities in the United States are significant users of radiological sources contained in medical devices used primarily for cancer treatment and research. The amount of radiation emitted by the sources in these devices varies according to the size and type of source. For example, teletherapy machines contain a single cobalt-60 source ranging from about 1,000 to 10,000 curies, while irradiators can occasionally contain up to 27,000 curies or more of cesium-137. The following section provides our preliminary findings on our ongoing work.

¹⁸GAO, *Nuclear Nonproliferation: DOE's International Radiological Threat Reduction Program Needs to Focus Future Efforts on Securing the Highest Priority Radiological Sources*, [GAO-07-282](#) (Washington, D.C.: Jan. 31, 2007).

NRC's Security Requirements Do Not Prescribe Specific Measures for Protecting Radiological Sources at Hospitals and Medical Facilities

NRC, which is responsible for regulating the security of radiological sources in U.S. hospitals and medical facilities, issued a security order in 2005 that directed licensees possessing radiological sources of concern to implement increased controls for access, detection and assessment, material shipments, physical barriers, information protection, and sensitive information.¹⁹ NRC has relinquished jurisdiction for licensing and regulating radiological sources to 37 states called Agreement States, whose offices are typically administered by state health or environment departments, and which inspect licensees to ensure compliance with state regulations that are generally compatible with NRC regulations. The Department of Veterans Affairs and DOD, which maintain a network of hospitals and medical facilities in the United States, are also required to meet the NRC security order for radiological sources of concern at their facilities.

NRC's security order and implementation guidance are broadly written and do not prescribe the specific steps that licensees must take to secure their sources. Rather, they provide a general framework for what constitutes adequate security practices. According to NRC, the intent of the increased controls is not to provide absolute security from theft or unauthorized access. Rather, the intent is to develop a combination of people, procedures, and equipment that will delay and detect an intruder, and initiate a response to the intrusion. In addition, the controls provide minimum requirements that a licensee must implement, and licensees may go beyond the minimum requirements. However, the ultimate responsibility for securing radiological materials in the United States rests with the licensees that possess these materials.

¹⁹A licensee is a company, organization, institution, or other entity to which the NRC or an Agreement State has granted a general license or specific license to construct or operate a nuclear facility, or to receive, possess, use, transfer, or dispose of source material, byproduct material, or special nuclear material. Security orders contain requirements for licensees to implement, including interim compensatory security measures beyond that currently required by NRC regulations or licenses. Some of the requirements formalize a series of security measures that licensees took in response to advisories NRC issued in the aftermath of the September 11 terrorist attacks. NRC's regulations impose requirements that licensees must meet in order to use nuclear materials or operate a nuclear facility. NRC has undertaken a rulemaking to promulgate regulations addressing the physical protection of byproduct materials. That rulemaking is currently under review by the Commission.

The security order directs that licensees limit access to radiological sources and develop a documented program to detect, assess, and respond to unauthorized access. The controls do not prescribe the types of physical security needed. It is up to the licensee to determine, for example, if security cameras are necessary or what types of locks or alarms are needed to secure doors or windows. For some locations, such as blood banks, requirements for access control can be met if the room where the medical device is located is staffed 24 hours a day, 7 days a week by an individual, or individuals, who are determined to be trustworthy and reliable. As long as the room is staffed at all times, the facility is not required to have any additional physical security, such as cameras or motion detection equipment. As a result, the only access control in place could be one or more staff members.

NRC also requires that hospitals and medical facilities verify the trustworthiness and reliability of individuals who are granted unescorted access to the medical devices containing radiological sources. The trustworthiness and reliability process requires that hospitals conduct a background check using information such as employment history, academic records, and other relevant information. It is ultimately the responsibility of the licensee to decide whether to grant the employee unescorted access. In 2007, NRC issued an additional security order requiring individuals employed at facilities containing highly radioactive sources to undergo fingerprinting with verification through the Federal Bureau of Investigation.

According to NRC officials, the requirements are intentionally broad to allow licensees flexibility to tailor security upgrades to their specific facility and operations. The ability to tailor security to a facility's needs and resources is particularly important for commercial facilities with limited resources. For example, officials from smaller medical facilities told us that implementing specific security requirements—such as cameras and other surveillance equipment—could jeopardize their continued operations because of the costs associated with this equipment. NRC officials told us that given factors such as diverse economic conditions, facility type, layout, and operations of facilities, a “one size fits all” approach is neither practical nor desirable.

We found that the NRC controls have been implemented in a variety of ways in the hospitals and medical facilities we visited in seven states and District of Columbia. These approaches have created a mix of security controls and procedures that could leave some facilities' radiological sources more vulnerable than others to possible tampering, sabotage, or

outright theft. At some locations, the controls resulted in significant security upgrades, such as the addition of surveillance cameras, upgrades to locks on doors, and alarms. In contrast, we observed minimal security in other facilities. Moreover, law enforcement personnel from states with significant amounts of high-activity radioactive sources at hospitals and medical facilities told us that the NRC controls have an inherent weakness: the controls do not specify what the facility is protecting against and are not linked to a design basis threat.²⁰ Typically, a design basis threat characterizes the elements of a potential attack, including the number of attackers, their training, and the weapons and tactics they are capable of employing. Although NNSA does not use a design basis threat for its security assessments of hospitals and medical facilities, it does employ a threat scenario (known as potential adversary capability) as the basis for its recommendations for security enhancements. According to a VA official, VA initially developed a generic threat scenario for use at its facilities with larger activity sealed radiological sources since NRC did not provide a design basis threat as part of the increased controls. Later, VA partnered with NNSA to implement security enhancements based on the NNSA threat scenario.

All of the 25 medical facilities we visited have implemented the controls and undergone inspections by either NRC or Agreement State inspectors, but we observed a number of potential security weaknesses.²¹ For example:

- At a hospital in one state, two cesium-137 research irradiators using approximately 2,000 curies and 6,000 curies, respectively, are housed in the basement of a building that is open to the public. The hallway leading to the irradiator room has a camera, but it is pointed away

²⁰NRC noted that, according to IAEA's Nuclear Security Series Implementation Guide No. 11, "Security of Radioactive Sources," the design and evaluation of a security system should take into account the current national threat assessment and may include the development and application of a design basis threat, although it is not required. According to IAEA, a design basis threat includes the attributes and characteristics of a potential insider and/or external adversaries, who might attempt unauthorized removal or sabotage, against which a physical protection system is designed and evaluated.

²¹The 25 sites we visited are a non-generalizable sample, selected on the basis of the number of radiological devices in the state and the total number of cumulative curies contained in these devices in each state. In addition, we also considered if the site had undergone security upgrades funded by NNSA, and if the site is located in a large urban area.

from the room. The door to the room is opened by a swipe card lock, and there are no cameras or other security measures inside the room. We observed that one of the irradiators was sitting on a wheeled pallet. When we asked the radiation safety officer (RSO)—the designated hospital official responsible for the security of radiological sources—if he had considered removing the wheels, he said no. This response was given even though the irradiator room is located in close proximity to an external loading dock, and the cameras along the corridor to the loading dock are displayed on a single monitor. This facility had passed its most recent NRC security inspection because access to the room where the irradiators were located was restricted through use of a swipe card. However, it could be vulnerable because of the limited security we observed and the potential mobility of the device.

- At a hospital in a major U.S. city, we observed that the interior door to the hospital blood bank, which had a cesium-137 blood irradiator of approximately 1,500 curies, had the combination to the lock written on the door frame. The door is in a busy hallway with heavy traffic, and the security administrator for the hospital said that he often walks around erasing door combinations that are written next to the locks. According to NRC, a single lock is not necessarily a security weakness, however, they noted that writing combinations on the door is a weakness.
- The RSO at a university hospital in another state told us that he did not know the exact number of individuals with unescorted access to the hospital's radiological sources, although he said that there were at least 500 people—the current data system does not allow for entering records of individuals beyond 500. In the past, he said, the hospital had as many as 800 people with unescorted access to sources. In contrast, at a major medical research facility at a military installation we visited, access was limited to 4 safety and security personnel.
- At a blood center in a third state we visited, we observed a cesium-137 blood irradiator of approximately 1,400 curies in a room that was secured by a conventional key lock. The irradiator was located in the middle of the room and not secured to the floor. The room had an exterior wall with a bank of unalarmed and unsecured windows that looked out onto a loading dock. The blood center officials said that while they met the controls, they acknowledged that the center is highly vulnerable to theft or sabotage of their radiological sources. According to NRC, an irradiator sitting in the middle of the floor not bolted down is not necessarily vulnerable.

Licensees are responsible for implementing the security requirements, including designing a security plan and implementing it. Implementation includes procuring and installing surveillance and alarm equipment that the licensees believe is adequate to protect the radiological materials in their facilities. However, many of the officials at the 25 hospitals and medical facilities we visited told us that they have backgrounds in radiological safety and facilities management and have limited security experience. Furthermore, none of these officials has been trained in how to implement the controls. For example:

- At another hospital we visited, the RSO said that when the controls were instituted in 2005, his new responsibilities included ensuring the security of a cobalt-60 gamma knife of approximately 2,600 curies and a cesium-137 blood irradiator of about 2,400 curies. He told us that he was not comfortable with his security role because his training was as a health physicist.²²
- One facility manager who oversees the security for an approximately 1,700 curie cesium-137 blood irradiator at a blood bank told us that he has a background in construction, not security. He said that it would have been helpful if NRC's controls were more specific so that he would be in a better position to determine what security measures were necessary to adequately protect the device.

According to NRC, NRC and Agreement State inspectors receive training in security inspections. They also noted that only qualified inspectors can conduct security inspections. Qualification includes training and inspection accompaniments with qualified inspectors. However, some inspectors from NRC and Agreement States we interviewed told us that they do not feel comfortable conducting security inspections at hospitals and medical facilities, despite having received this training. For example, an NRC inspector said that security inspections were particularly difficult for her because she is trained as a physicist. She said that the controls were confusing, and she did not understand the nuances of security. An Agreement State inspector from another state we visited also told us that he was not qualified to do security inspections. However, he said that he

²²Health physics is a science concerned with recognizing and evaluating the effects of radiation on the health and safety of people and the environment, monitoring radiation exposure, and controlling the associated health risks and environmental hazards to permit the safe use of technologies that produce radiation.

was doing the best he could to interpret the controls and help the licensees implement the requirements. Other inspectors from this state told us that they were placed in the awkward situation of having to enforce regulations that they did not believe they were fully qualified to interpret.

We also found that Agreement States lacked sufficient staff and adequate training to ensure the security of radiological sources, according to recent NRC reviews of two Agreement States' inspection programs.²³ For example, NRC's review of one of the state's radioactive materials program found that the program experienced significant turnover and that inspectors did not have an adequate understanding of the controls. According to a state official, high staff turnover and the resulting lack of security experience affected the quality of their oversight. As a result, inspectors had difficulty assessing licensee compliance with the security requirements. According to NRC's review of the other state's radioactive materials program, the state's newer inspectors would have benefitted from additional training on NRC's security requirements. A state inspector told NRC that he did not understand the meaning of some of the documentation he was reviewing. Another state official stated that he was authorized to inspect a radiological device independently (without being accompanied by a more experienced inspector) before he was ready to do so. Furthermore, according to state officials, staff turnover has significantly affected the state's timely follow-up of increased controls violations. NRC told us that they plan, based on the findings of these reviews, to take action in future reviews to remedy these problems.

NNSA Has Secured Radiological Sources at U.S. Hospitals and Medical Facilities

According to NNSA, there are approximately 1,500 hospital and medical buildings in the United States—that they have identified—that contain high-activity radiological sources. NNSA also estimates that these buildings cumulatively contain about 22 million curies of radioactive material.²⁴ One of GTRI's components is the Domestic Material Protection

²³NRC's Integrated Materials Performance Evaluation Program reviews Agreement State programs to ensure that they meet NRC's standards. Since 2006, NRC has conducted 41 reviews that contained reports on state's performance regarding the inspection and licensing of the increased controls. Of the 41 reviews, 4 noted problems with how the state was implementing the increased controls.

²⁴According to NNSA, this estimate reflects the amount of curies for the licensed maximum for each device. It does not reflect what the actual amount of curies may be, because curie levels diminish as the device is utilized.

program, which further improves security beyond NRC and Agreement State regulatory requirements at U.S. facilities with high-activity radiological sources, including hospitals and medical facilities.²⁵ This voluntary program provides, among other things, U.S. hospitals with security upgrades to the devices that contain high-activity radiological sources. It also provides training for hospital personnel and local police departments through its Alarm Response Training program at the Y-12 National Security Complex in Oak Ridge, Tennessee. This training is designed to teach facility personnel and local law enforcement officials how to protect themselves and their communities when responding to alarms indicating the possible theft or sabotage of nuclear or radioactive materials. NNSA funds the cost of the security upgrades and training. However, the licensee is responsible for maintaining the security systems once the 3-to-5-year warranty period established by NNSA expires. NNSA officials told us that they estimated the average cost of maintaining the upgrades at each hospital was typically less than \$10,000 per year.

According to NNSA officials, as of December 2011, the program spent an estimated \$96 million to secure radiological sources at 302 U.S. hospitals and medical facilities. The program plans to complete voluntary security upgrades at all 1,503 hospital and medical buildings it has identified as high-risk by 2025, at a projected cost of \$608 million. NNSA officials told us that they estimate the average cost to upgrade a medical building has been \$317,800.²⁶ We plan to analyze these expenditures more fully during the course of our review.²⁷

Of the 25 hospital and medical facilities that we visited in seven states and the District of Columbia, 13 have received GTRI upgrades and three were in the process of receiving the upgrades. Officials from most of the 16 hospitals and medical facilities told us that GTRI's program enhanced the security of their facilities. We observed a number of security upgrades at the facilities we visited, including remote monitoring systems, surveillance cameras, hardened doors, iris scanners, motion detectors, and tamper-proof alarms. NNSA has established criteria for determining

²⁵The upgrading of hospitals and medical facilities is one component of GTRI's Domestic Material Protection program, which also secures high-activity radiological sources in other commercial facilities and sites.

²⁶According to NNSA officials, training costs were excluded from the data.

²⁷These cost estimates are of undetermined reliability.

which hospitals are eligible for assistance; it ranks facilities to be upgraded based on the relative risk of the radiological sources and expected risk reduction resulting from the planned GTRI activity. The criteria NNSA uses include the following: the attractiveness for theft or diversion of nuclear and radiological materials; existing site security conditions; threat environment; and location to a potential target, such as a large population center.

Some hospital officials and police department personnel told us that the GTRI program is limited because it is a voluntary program and because of the potential financial burden placed on hospitals and medical facilities to maintain the upgrades beyond the 3- to 5-year warranty period. We found that some hospitals have declined the upgrades, including hospitals located in high-risk urban areas. For example:

- At a blood bank in one of the states we visited with a cesium-137 blood irradiator of approximately 1,400 curies, staff told us that NNSA was prepared to upgrade the bank's security, but the blood bank decided not to participate because senior management wanted to wait until the blood bank moved to a new location, which it planned to do within the next 3 years. We observed that the blood irradiator appeared vulnerable—it was visible through an unalarmed and unsecured bank of windows overlooking an exterior loading dock. In February 2012, we contacted NNSA officials about this matter. As a result, NNSA and national laboratory officials met with the facility and developed a plan to secure the irradiator before the end of the fiscal year.
- According to police department officials from one major U.S. city, one hospital with a blood irradiator of approximately 1,700 curies has declined the GTRI upgrades, even though the police department considers it a high-risk facility. The hospital officials told us in February 2012 that they decided not to implement the GTRI upgrades because of concerns about maintenance costs associated with the security equipment after the NNSA-funded warranty period expired. The RSO said that the security the hospital has in place is adequate. Furthermore, the hospital is under serious budget pressure that makes it difficult to justify spending more money on protecting the sources.

Under the GTRI program, NNSA also upgrades some smaller sources, such as those contained in brachytherapy devices.²⁸ Typically, these devices contain between 10 and 15 curies of iridium-192. The curie level is not considered high enough to be subject to NRC's security controls, but NNSA officials told us that the devices' portability makes them a potential target for theft. NNSA officials stated that GTRI completed security upgrades at some sites before they considered including brachytherapy devices. GTRI is in the process of revisiting these sites and implementing security enhancements. We observed GTRI upgrades for brachytherapy devices at some hospitals, including a device that was put in a locked closet. However, we did visit one GTRI-upgraded facility where the security of the brachytherapy device had not been upgraded. In this facility, there were no security cameras monitoring the area, and in particular, there were no cameras in the room where the device was located. Furthermore, access to the room was controlled by a wooden door with a padlock, and we observed a hospital official retrieve the key to the padlock from an unlocked desk immediately outside the door. Upon entering the room, we observed that the device was not secured to the floor, as required by the hospital's own security protocol.

We are continuing to conduct our audit and plan to visit some additional medical facilities in the United States. We plan to issue our report later this year.

Chairman Akaka, Ranking Member Johnson, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions you may have at this time.

GAO Contact and Staff Acknowledgements

If you or your staff have any questions about this testimony, please contact me at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. GAO staff who made key contributions to this testimony are Glen Levis, Assistant Director; Jeffrey Barron; Alysia Davis; William Hoehn; Will Horton; and Michelle Munn.

²⁸A brachytherapy device typically involves inserting radioactive material into the body near the treatment site.

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