



September 2015

# NUCLEAR NONPROLIFERATION

DOE Made Progress  
to Secure Vulnerable  
Nuclear Materials  
Worldwide, but  
Opportunities Exist to  
Improve Its Efforts

## Why GAO Did This Study

In April 2009, President Obama announced an initiative to secure all vulnerable nuclear materials—such as those that could be stolen by terrorists and used to construct a nuclear device—within 4 years. DOE is primarily responsible for activities under this initiative, but the Nuclear Regulatory Commission (NRC), the Departments of Defense (DOD) and State, and the National Security Council (NSC) also have roles. GAO was asked to examine actions taken under this initiative.

This report (1) assesses the extent to which DOE achieved its goals for four key activities under the initiative and (2) examines DOE's goals going forward and assesses challenges that may limit its ability to secure additional vulnerable nuclear materials. GAO reviewed relevant documents and interviewed officials from DOE, NRC, DOD, and State, as well as discussed these issues with officials from NSC and selected foreign government agencies. This is a public version of a classified report GAO issued in August 2015.

## What GAO Recommends

GAO continues to believe that DOE and other U.S. agencies should complete an inventory of U.S. plutonium at worldwide sites as GAO recommended in September 2011. In this report, GAO recommends that DOE complete its prioritization of nuclear materials at foreign locations. GAO also recommends that DOE and other agencies visit sites containing key quantities of U.S. nuclear materials that have not been visited in at least 5 years. DOE agreed with GAO's recommendations.

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## NUCLEAR NONPROLIFERATION

### DOE Made Progress to Secure Vulnerable Nuclear Materials Worldwide, but Opportunities Exist to Improve Its Efforts

## What GAO Found

The Department of Energy (DOE) achieved goals for two of its four key activities under the President's 2009 initiative to secure all vulnerable nuclear materials within 4 years. Specifically, from April 2009 through December 2013, GAO's analysis of DOE's records found that DOE exceeded its goal for removing or disposing of 1,201 kilograms of highly enriched uranium (HEU) or plutonium by more than 400 kilograms, and it exceeded its goal of downblending (i.e., mixing HEU with either depleted or natural uranium, or low-enriched uranium (LEU), to produce a new product that has a lower concentration of uranium-235) 2,700 kilograms of HEU by an additional 2,200 kilograms. However, it missed its goal for providing physical protection upgrades at 43 buildings by 11 buildings and missed its goal of converting 34 foreign reactors to more proliferation-resistant LEU by 11 reactors. DOE officials said that political challenges, including access to key sites, and technical concerns such as delays in the development of LEU replacement fuels for certain high-performing nuclear reactors, complicated its efforts to achieve these goals.

DOE has developed new goals since the end of the 2009 initiative for efforts related to the initiative's four key activities. For example, DOE's goal is to remove or dispose of an additional 1,029 kilograms of fresh and spent HEU, as well as plutonium worldwide from 2014 to December 2019, and convert 27 foreign research reactors and medical isotope production facilities to LEU by the end of fiscal year 2019. However, GAO identified several challenges that may hamper future progress. For example, DOE and other U.S. agencies have not completed an inventory of U.S. plutonium overseas as GAO previously recommended in September 2011. DOE and the other agencies did not agree with this recommendation, citing such an effort was impractical and unwarranted. Without such an inventory, the U.S. government is not able to identify where vulnerable weapons-usable materials such as plutonium reside. In addition, DOE has neither completed a prioritization of nuclear materials, including recently identified U.S.-origin HEU, at foreign locations for return or disposition to identify the most vulnerable material stocks to focus efforts on, nor established a time frame for doing so. Another challenge GAO identified is that DOE and other agencies have not visited key sites to determine whether U.S. nuclear material on-site is protected according to international physical security guidelines. Specifically, GAO identified 11 key sites that hold more than 3,500 kilograms of U.S.-origin HEU that DOE and other agencies have not visited in more than 20 years to determine whether they are protected according to international physical security guidelines. DOE has taken steps to develop a methodology for selecting and prioritizing physical protection visits but has not yet provided GAO with a time frame for prioritizing and conducting such visits. Without an assessment of the physical security conditions of U.S.-origin nuclear materials at sites containing key quantities of such material, it may be difficult to ensure that such materials are being adequately protected in accordance with international physical security guidelines, and that DOE and U.S. agencies are removing or disposing of the most vulnerable nuclear materials.

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### Abbreviations

DOD	Department of Defense
DOE	Department of Energy
EA	Environmental Assessment
EIS	Environmental Impact Statement
EURATOM	European Atomic Energy Community
GTRI	Global Threat Reduction Initiative
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
LEU	low-enriched uranium
MNEPR	Multilateral Nuclear Environmental Programme in the Russian Federation
MPC&A	Material Protection, Control and Accounting
MTR	Material Test Reactor
NEPA	National Environmental Policy Act
NMIP	Nuclear Materials Information Program
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NSC	National Security Council
State	Department of State
TRIGA	Training, Research, Isotope General Atomic

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September 23, 2015

The Honorable John McCain  
Chairman  
The Honorable Jack Reed  
Ranking Member  
Committee on Armed Services  
United States Senate

The Honorable James Inhofe  
United States Senate

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 highly enriched uranium (HEU), separated plutonium, or other nuclear materials. Vulnerable nuclear materials stolen from poorly secured stockpiles in various locations around the world could be used to construct a nuclear device.<sup>1</sup> According to a 2013 study,<sup>2</sup> roughly 780,000 kilograms of HEU and 226,000 kilograms of separated plutonium exist outside the United States, including more than 617,000 kilograms of HEU and 120,000 kilograms of plutonium in Russia. The administration has proposed strengthening and expanding U.S. efforts to reduce nuclear proliferation risks and improve nuclear security worldwide. In April 2009, President Obama announced a

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<sup>1</sup>Materials that can be used to construct a nuclear device are HEU—uranium enriched in the isotope uranium-235 to 20 percent or greater; uranium-233; and any unirradiated or “separated” plutonium containing less than 80 percent of the isotope plutonium-238. In general, when referring to plutonium in this report, we mean “separated plutonium,” rather than the plutonium that is generated during the irradiation of uranium-based nuclear fuel and remains with the uranium and fission products within those fuel pins and assemblies. These materials are also often referred to as fissile materials or special nuclear materials. In addition, weapons-grade HEU is HEU that requires no further enrichment before use in a nuclear device, and it is generally defined as HEU enriched in the isotope of uranium-235 at 90 percent or greater. HEU can be downblended by mixing it with either depleted or natural uranium, or low-enriched uranium (LEU) to convert it into a new product that is less than 20 percent uranium-235. LEU contains less than 20 percent and greater than 0.7 percent of uranium-235 and is considered to not be weapons-usable. Most commercial reactor fuel is enriched to between 3 percent and 5 percent uranium-235.

<sup>2</sup>Arms Control Association and Partnership for Global Security, *The Nuclear Security Summit: Progress Report* (Washington, D.C.: July 2013).

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new international initiative to secure all vulnerable nuclear materials around the world within 4 years. After this announcement, the National Security Council (NSC)—the President’s principal forum for considering and coordinating national security and foreign policy matters with his senior national security advisors and cabinet officials—issued a document providing further details regarding the initiative.<sup>3</sup> According to the document, the initiative’s focus is on programs to secure vulnerable nuclear materials, specifically site lockdown programs.<sup>4</sup>

The NSC document stated that vulnerable nuclear materials include HEU, uranium-233, and plutonium that are not secured in accordance with International Atomic Energy Agency (IAEA) international physical security guidelines.<sup>5</sup> The document further stated the initiative would also seek to integrate, where and when possible, the most recent revisions of the international physical security guidelines. These guidelines provide recommendations for the physical protection of nuclear material against unauthorized removal during its use, storage, and transport, as well as recommendations for protection against sabotage of nuclear material or facilities. According to the initiative document, in addition to the NSC, the agencies involved in the initiative are the Department of Energy (DOE),

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<sup>3</sup>National Security Council, *Interagency Efforts to Improve the Security of Weapons and Fissile Materials*. In 2011, the NSC circulated a written statement to U.S. agencies noting that the initiative would terminate at the end of 2013, but the goal of removing and securing vulnerable nuclear materials worldwide would continue as long as such materials exist.

<sup>4</sup>The initiative also called for strengthening foreign countries’ capability to deter, detect, and interdict illicit smuggling of nuclear materials across international borders, among other things. Our report focuses on the following four key activities to secure or remove HEU and plutonium: (1) removing or disposing of HEU and plutonium to secure locations in the United States or elsewhere; (2) downblending HEU to LEU;(3) upgrading the physical protection of HEU and plutonium at vulnerable sites; and (4) converting nuclear reactors and associated facilities that use HEU to LEU.

<sup>5</sup>The version of the guidelines in effect at that time was revision 4, published in 1999. IAEA, “Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities,” (IAEA INFCIRC/225/Rev.4 (1999)). IAEA is an independent international 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. In January 2011, IAEA published a fifth revision to this document. Because it represents guidelines for international physical security, IAEA member states are not obliged to follow the document. Furthermore, partner countries may decline offers of U.S. or international assistance to secure or remove nuclear materials.

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Department of Defense (DOD), Department of State (State), and the Nuclear Regulatory Commission (NRC). Because the key activities associated with removing and securing HEU and plutonium are primarily undertaken by DOE, this report focuses on DOE's contributions, but it also includes information regarding the contributions of the other federal agencies involved in the initiative, as appropriate.

#### **U.S.-Origin and U.S.-Obligated Nuclear Materials**

A nuclear cooperation agreement is a bilateral agreement that establishes the legal framework for significant civilian nuclear cooperation between the United States and other parties, including for the transfer of U.S. exported nuclear material such as uranium and plutonium. Nuclear cooperation agreements must establish certain rights and obligations that the United States and its partners have with regard to such cooperation. For example, these agreements must obligate partner countries to maintain adequate physical security and must establish U.S. rights of approval regarding the transfer, retransfer, enrichment and reprocessing, and storage of nuclear materials. U.S.-obligated nuclear material refers to U.S.-origin nuclear material, and material produced overseas through the use of U.S.-origin nuclear material, or U.S.-supplied nuclear reactors. For this report, where feasible, we will examine the physical security afforded U.S.-obligated nuclear material, as well as nuclear material of other origin. For more information, see GAO-11-920.

Source: GAO. | GAO-15-799

We have examined the initiative and assessed U.S. efforts to promote worldwide nuclear security in prior reports. Specifically, we found in December 2010 that NSC's interagency strategy did not include specific details concerning how the initiative would be implemented, and that essential details associated with the initiative were unclear, including the initiative's time frames and scope of work.<sup>6</sup> In that report, we also found that the initiative did not include specific details concerning the identity of vulnerable nuclear material sites and facilities to be addressed, planned activities at each location, anticipated timelines, and cost projections. We recommended that the NSC lead the development of a more detailed interagency implementation plan for the initiative. Although it provided technical comments, NSC did not provide a formal written response to the report or its recommendations. In addition, in September 2011,<sup>7</sup> we found that U.S. agencies had limited ability to account for, monitor, and evaluate the security of U.S. nuclear material overseas. In that report, we also found that many sites with U.S. nuclear material had never been visited by a U.S. interagency physical protection team.<sup>8</sup> Moreover, we found that when U.S. teams were granted permission to make such visits from 1994 through 2010, partner countries met international physical security guidelines only about half of the time. We suggested that Congress should consider directing DOE and NRC to compile an inventory of U.S.

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<sup>6</sup>GAO, *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).

<sup>7</sup>GAO, *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).

<sup>8</sup>U.S. interagency physical protection teams visit partner country facilities to monitor and evaluate whether the physical protection provided to U.S. nuclear material meets IAEA physical security guidelines. The U.S. teams visit certain facilities where U.S. nuclear material is used or stored to observe physical protection measures after discussing the relevant nuclear security regulatory framework with the partner government, and make recommendations for upgrading the physical protection of HEU and plutonium at sites that are not protected according to current international physical security guidelines.



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HEU and separated plutonium overseas.<sup>9</sup> We also recommended that the Secretary of State facilitate visits where feasible to sites that had not been visited by a U.S. team, and that the Secretary of Energy develop a more systematic process for identifying and prioritizing future physical protection visits. State, DOE, and NRC disagreed with our recommendations. The status of these recommendations is discussed later in this report.

You asked us to assess the progress of the 2009 initiative. This report (1) assesses the extent to which DOE achieved its goals associated with the initiative's four key activities and (2) examines DOE's goals since the end of the initiative associated with the four key activities and identifies and assesses challenges, if any, that may limit DOE's ability to secure as much vulnerable nuclear material as possible.

This report is a public version of a classified report that we provided to you in August 2015. DOE deemed some of the information in the classified report as Secret, which must be protected from public disclosure. Therefore, this report omits certain information about vulnerabilities that remained at the end of the initiative. Although the information in this report is more limited in scope, the overall methodology used for both reports is the same.

To conduct this work, we reviewed relevant documents and interviewed federal officials responsible for implementing the initiative. In particular, to assess the extent to which DOE achieved its goals associated with the initiative's four key activities, we reviewed NSC's interagency strategy document to identify the primary objectives of the initiative and determine how DOE and participating federal agencies were expected to contribute in meeting these objectives. We also reviewed DOE's 2009 classified plan and fiscal year 2010 budget request—which was released in May 2009—to identify the goals DOE had established at the initiative's start for

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<sup>9</sup>The report further stated that without an accurate inventory of U.S. nuclear materials, including separated plutonium, the United States may not be able to monitor whether it is receiving the notifications it needs from partner countries to exercise its rights of approval regarding the transfer, retransfer, enrichment and reprocessing, and in certain cases, the storage of nuclear materials subject to nuclear cooperation agreement terms.

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contributing to the initiative's four key activities.<sup>10</sup> We reviewed DOE and agencies' documentation regarding these efforts. We interviewed officials from DOE, DOD, NRC, and State and discussed these issues with NSC to determine the extent to which these agencies contributed to the initiative. We also sent a data collection instrument to key offices in DOE, DOD, NRC, and State to identify how much each agency spent on the initiative. We adjusted the data for inflation, and all data are in 2014 dollars unless otherwise noted. To assess the reliability of these data, we manually tested them for missing values, obvious errors, or outliers; we compared the data with related budget information available in the agencies' budget requests. We also included questions in our data collection instrument and received responses regarding how agencies compiled the data and maintained their data quality and data systems, and we interviewed knowledgeable agency officials to discuss the data. We determined that the data were sufficiently reliable for the purposes of this report.

To examine DOE's goals associated with the four key activities since the end of the initiative, and to assess any challenges that may limit DOE's ability to secure as much vulnerable nuclear material as possible, we reviewed the agency's goals as outlined in its fiscal year 2015 budget request, released in March 2014, as well as relevant agency documents. We also collected estimated spending data from DOE and other agencies related to activities going forward. In addition, we interviewed officials from DOE, DOD, NRC, and State to learn more about how they plan to contribute to the key activities going forward, as well as challenges that may lie ahead. To obtain additional information regarding any challenges that may limit DOE's ability to secure as much vulnerable nuclear material as possible, we analyzed key U.S. government data sources, including records of DOE priorities and returns of nuclear materials, and records of U.S. physical protection visits. We visited DOE's Savannah River Site to meet with officials responsible for some of the nuclear materials returned to the United States during the initiative. We also visited sites in three countries that hold or held U.S.-origin HEU in and interviewed foreign

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<sup>10</sup>DOE's Global Threat Reduction Initiative (GTRI) has a metric for removing and disposing of HEU and plutonium. In practice, GTRI has considered the downblending of material to constitute the disposal of such material and thus count toward this metric. DOE's Material Protection, Control and Accounting program has a separate metric for the downblending of material. For the purposes of this report, we are evaluating the two offices according to the metrics that they used during the time of the initiative for these activities.

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country representatives regarding processes for identifying and returning vulnerable nuclear materials in accordance with initiative aims. We identified and analyzed DOE and other U.S. agency information regarding their programs for ensuring that U.S.-nuclear materials are physically protected consistent with international security guidelines at foreign locations, and we reviewed DOE information regarding planned nuclear material removals and dispositions. Additional details on our objectives, scope, and methodology can be found in appendix I.

We conducted this performance audit from February 2014 to September 2015 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.

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## Background

The NSC document describing the initiative called for a U.S. interagency effort, with the NSC coordinating U.S. activities to secure and remove vulnerable nuclear materials worldwide. DOE has the largest agency role in undertaking initiative-related activities.<sup>11</sup> Several offices within DOE and other U.S. agencies and agency offices are also involved in the initiative. Specifically,

- DOE's Global Threat Reduction Initiative (GTRI) program works to reduce and protect vulnerable nuclear material located at civilian sites worldwide. In particular, it has programs to remove or confirm the disposition of excess HEU and plutonium, including U.S.-origin and material of other country origin, and convert research reactors and isotope production facilities to the use of LEU and nonweapons-usable materials. GTRI focuses primarily on the initiative's key activities of removing and disposing of HEU and plutonium and

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<sup>11</sup>In January 2015, DOE reorganized its Office of Defense Nuclear Nonproliferation. This included combining certain functions of DOE's Global Threat Reduction Initiative (GTRI) and Material Protection, Control, and Accounting (MPC&A) programs into the newly-formed Office of Material Management and Minimization and Office of Global Material Security. Because this report reviews activities undertaken prior to this reorganization, and the planned expenditures and activities were reported to us by GTRI and MPC&A prior to this reorganization, this report refers to DOE's offices and activities in place prior to the January 2015 reorganization.

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converting reactors and isotope production facilities to the use of nonweapons-usable material.

- DOE's Material Protection, Control and Accounting (MPC&A) program works with Russia, other former Soviet states, and other partner countries to improve the security of nuclear weapons and HEU and plutonium at their source and to promote nuclear security best practices. With respect to the initiative's key activities, MPC&A is responsible for verifying the downblending of HEU in Russia to LEU and for upgrading the physical protection of HEU and plutonium.
- DOE's Office of Nonproliferation and International Security coordinates interagency physical protection visits to partner countries holding key quantities of U.S.-origin HEU and plutonium to assess sites' security status and ensure that the physical protection measures afforded U.S.-obligated material meet international physical security guidelines.
- DOE's Office of Intelligence and Counterintelligence, both a DOE component and a member of the Intelligence Community, works with U.S. agencies and the Intelligence Community to combine reporting into and manage the Nuclear Materials Information Program (NMIP), an interagency effort that provides, among other things, information regarding the location, quantities, and vulnerabilities of sites storing HEU and plutonium worldwide.
- DOE's Office of Environmental Management works to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored nuclear energy research. This effort contributes to the initiative's key activity of removing HEU and plutonium to secure locations in the United States.
- State manages nuclear nonproliferation programs, supports the nuclear nonproliferation programs of other U.S. agencies working overseas, and conducts bilateral and multilateral diplomacy to address proliferation threats around the world under the Bureau of International Security and Nonproliferation. State's primary contribution to the initiative's activities includes fostering bilateral and international cooperation toward initiative objectives.
- DOD's Cooperative Threat Reduction program works to eliminate and prevent the proliferation of weapons of mass destruction. The program contributes to the initiative's key activities of removing and

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securing HEU and plutonium and upgrading the physical protection of HEU and plutonium by facilitating the safe and secure transport and storage or elimination, among other things, of nuclear weapons and weapons-usable nuclear materials.

- NRC regulates the export of nuclear materials, including HEU and plutonium, through licensing, inspection, and enforcement of its requirements. NRC's licensing for the export of U.S. nuclear equipment and HEU and plutonium is conditioned on the partner country maintenance of adequate physical security measures, international safeguards, and other relevant criteria. NRC, as a member of the U.S. interagency group, is involved in the planning and implementation of physical protection visits to facilities holding or requesting to receive U.S.-obligated nuclear materials.

The framework for accomplishing the goals of the initiative includes U.S. laws, agency regulations and programs, and international and bilateral commitments. Through this framework, the United States works with other countries to monitor and ensure the physical security of nuclear materials abroad, and, where feasible, to facilitate the removal of vulnerable nuclear materials. The United States works with other countries primarily within the framework of the IAEA, U.S. nuclear cooperation agreements, U.S.-Russia agreements, and U.S. fuel and nuclear material return programs. A description of each of these areas follows:

**IAEA:** IAEA plays a key role in supporting international efforts to ensure the security of nuclear materials in a number of ways. IAEA's international physical security guidelines provide the basis by which the United States and other countries generally classify the categories of protection that should be afforded special nuclear material,<sup>12</sup> based on the type, quantity, and enrichment of the nuclear material. For example, Category I nuclear material is defined as 2 kilograms or more of unirradiated or "separated" plutonium or 5 kilograms of uranium-235 contained in unirradiated or "fresh" HEU and has the most stringent set of recommended physical protection measures. Lower quantities of special nuclear material are

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<sup>12</sup>Special nuclear material includes plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235.

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referred to as Category II and Category III quantities.<sup>13</sup> In addition, IAEA aims to detect and deter the diversion of nuclear material for nonpeaceful purposes through its safeguards program. Under this program, IAEA inspects facilities and locations containing nuclear material, as declared by each country, to verify peaceful use, among other things. IAEA maintains information on holdings of worldwide nuclear materials for 179 countries but, according to IAEA officials, it does not share this information with other countries. IAEA also receives some information regarding the amount and kinds of nuclear material at all sites through its safeguards activities and International Physical Protection Advisory Service missions. These missions are conducted at the request of the host country and enable IAEA to assist countries in strengthening their national nuclear security regimes; however, this information is not shared with other countries. According to GTRI officials, the IAEA also supports DOE efforts to remove vulnerable nuclear material from and convert research reactors in other countries.

**U.S. nuclear cooperation agreements:** U.S. nuclear cooperation agreements and U.S. interagency physical protection visits provide another mechanism to ensure that U.S.-origin nuclear material overseas at partner sites is not vulnerable. As of October 2014, the United States had 21 nuclear cooperation agreements in force for peaceful civilian nuclear cooperation with partners including foreign countries, the European Atomic Energy Community (EURATOM), IAEA, and Taiwan.<sup>14</sup> The Atomic Energy Act of 1954, as amended, requires all U.S. nuclear cooperation agreements to contain guarantees that cooperating parties will maintain adequate physical security for transferred nuclear material

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<sup>13</sup>According to IAEA, as detailed in appendix II, fuel which by virtue of its original fissile material content is classified Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 100 rad/h at one meter unshielded. For the purposes of this report, we refer to irradiated material whose radiation level from the fuel exceeds 100 rad/h at one meter unshielded as “self-protecting,” and irradiated material whose radiation level from the fuel no longer exceeds 100 rad/h at one meter unshielded as “not self-protecting.” Appendix II contains further details on the categorization of nuclear material.

<sup>14</sup>EURATOM is composed of the 28 countries of the European Union. Governmental relations between the United States and Taiwan were terminated on January 1, 1979. All agreements concluded with the authorities of Taiwan prior to 1979 are administered for the United States by the American Institute in Taiwan, a nonprofit corporation based in Washington, D.C. In addition, according to NRC officials, the United States has signed Project and Supply Agreements with IAEA and several countries to facilitate exports of U.S. nuclear materials to support specific projects.

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and any special nuclear material used in or produced through the use of any material, or production or utilization facilities transferred pursuant to the agreement. However, as we found in our September 2011 report,<sup>15</sup> U.S. agencies' ability to monitor and evaluate whether nuclear material subject to U.S. nuclear cooperation agreement terms is physically secure and accordingly not vulnerable is contingent on partners granting access to facilities where nuclear material is stored. As we further reported, U.S. interagency physical protection teams have conducted physical protection visits to monitor and evaluate the physical security of U.S. nuclear material at facilities overseas when permitted.

**U.S.-Russian agreements:** A series of agreements between Russia and the United States has established a mechanism to facilitate U.S. participation in efforts to ensure the security of nuclear materials in Russia—a country estimated to hold at least 617,000 kilograms of HEU and 120,000 kilograms of plutonium. In 1991, Congress authorized DOD to establish the Nunn-Lugar Cooperative Threat Reduction program to provide nuclear security assistance to Russia and the former Soviet states. In June 2013, the Cooperative Threat Reduction umbrella agreement—which established an overall legal framework for providing such assistance—expired, and joint nuclear security activities in Russia since have been conducted under a 2003 Framework Agreement on a Multilateral Nuclear Environmental Programme in the Russian Federation (MNEPR). According to GTRI officials, GTRI's activities to return Russian-origin HEU and plutonium to Russia and convert reactors in Russia is covered by a May 2004 U.S.-Russia government-to-government agreement.<sup>16</sup>

**U.S. fuel and nuclear material return program:** Along with its work with Russia to help secure and protect former Soviet nuclear material, the United States has also actively sought to return U.S.-origin and, in some cases, nuclear material of other origins to the United States.<sup>17</sup> In general,

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<sup>15</sup>[GAO-11-920](#).

<sup>16</sup>“Agreement between the Government of the United States of America and the Government of the Russian Federation Concerning Cooperation for the Transfer of Russian-produced Research Reactor Nuclear Fuel to the Russian Federation,” May 27, 2004.

<sup>17</sup>For the purposes of this report, we will refer to removals of nuclear material for final disposition in the United States as a “return” of material, irrespective of the original origin of the material.

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unirradiated HEU is returned to the Y-12 National Security Complex near Oak Ridge, Tennessee; spent HEU is returned to either Idaho National Laboratory in Idaho Falls, Idaho, or the Savannah River Site in South Carolina; and separated plutonium is returned to the Savannah River Site. Because the process of returning the nuclear materials to the United States could potentially affect the environment, these returns are analyzed under the National Environmental Policy Act (NEPA).<sup>18</sup> DOE regulations for implementing NEPA dictate that these reviews should start “as soon as possible” after DOE proposes an action. Since 1996, DOE has completed several NEPA reviews related to the return of nuclear materials. In accordance with department policy, DOE pays for returns of material from non-high income countries but charges high income countries a fee.<sup>19</sup>

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## DOE Achieved Its Goals for Two of Four Key Activities

DOE achieved its goals for the initiative for the key activities of removing or disposing of HEU and plutonium and downblending HEU; however, it did not achieve its goals for upgrading the physical protection of HEU and plutonium at vulnerable sites or for converting reactors and associated facilities that use HEU to LEU.<sup>20</sup> We used DOE’s fiscal year 2010 budget request to identify the goals that DOE had established at the initiative’s start for the four key activities.<sup>21</sup> DOE reported that it had spent more than

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<sup>18</sup>Under NEPA, federal agencies generally are to evaluate the likely effects of projects they are proposing by either preparing an Environmental Assessment (EA) or a more detailed Environmental Impact Statement (EIS). Agencies may prepare an EA to determine whether a proposed project is expected to have a potentially significant impact on the human environment. If prior to or during the development of an EA the agency determines that the project may cause significant environmental impacts an EIS should be prepared.

<sup>19</sup>GTRI classifies certain countries as “other than high-income” as defined by the World Bank index of country income levels. For the purposes of this report, we refer to GTRI’s other than high-income countries as non-high income countries, and those countries not on the World Bank’s index as high-income countries.

<sup>20</sup>DOE also aims to convert research reactors and isotope production facilities from using HEU fuel or targets to LEU fuel and targets. HEU targets may be used in the manufacture of molybdenum-99, which is an important component of nuclear medicine. Specifically, HEU “target” material is irradiated to produce molybdenum-99, which is further processed to produce technetium-99m.

<sup>21</sup>We used DOE’s fiscal year 2010 budget request as a baseline because it was issued in May 2009, 1 month after the start of the initiative and, in the absence of other annually published, forward-looking information since the initiative’s start, we identified it as a reasonable indicator of DOE’s expectations and goals to be accomplished in the initiative.



\$650 million on its efforts during the initiative. Table 1 below summarizes DOE's progress toward its goals for the four key activities and the amount spent for each.

**Table 1: Department of Energy (DOE)'s Progress Toward Achieving Its Goals in Four Key Activities during the Global Nuclear Security Initiative (April 2009 through December 2013)**

Dollars in millions (fiscal year 2014 dollars)

Activity	Goal	Actual	Status	Amount spent
HEU and plutonium removed or disposed of	1,201 kilograms	1,616 <sup>a</sup> kilograms	Met goal	\$531
HEU downblended	2,700 kilograms	4,900 <sup>b</sup> kilograms	Met goal	\$70
Physical protection upgraded	43 buildings	32 buildings	Did not meet goal	\$49 <sup>c</sup>
Reactors converted	34 foreign reactors	23 foreign reactors	Did not meet goal	\$5
<b>Total</b>				<b>\$656</b>

Legend: HEU = highly enriched uranium; LEU = low-enriched uranium

Sources: GAO analysis of DOE's fiscal year 2010 budget request and Global Threat Reduction Initiative (GTRI) and Material Protection, Control and Accounting Program (MPC&A) data. | GAO-15-799

Notes: Quantities of HEU and plutonium are rounded to nearest kilogram. Total does not add due to rounding.

<sup>a</sup>DOE's Global Threat Reduction Initiative (GTRI) in 2013 reported that it had confirmed the disposition of 1,240 kilograms of HEU in the United Kingdom and 112 kilograms of HEU in Japan by confirming its downblending. However, we did not include these activities as achievements toward its goal because the downblending of HEU in the United Kingdom occurred many years prior to the initiative, and GTRI was not able to confirm the downblending of material in Japan occurred during the initiative and, in both cases, the extent to which GTRI played an active role in disposing of these materials was unclear. Because GTRI considers the downblending efforts it is involved in as a disposition activity, and includes these efforts as such in DOE's annual budget requests to Congress, we are including the material volumes and spending for GTRI's downblending in the removal and disposition category. In addition, we did not include 22 kilograms of HEU that GTRI removed from facilities within the United States during the initiative.

<sup>b</sup>DOE's Material Protection, Control and Accounting (MPC&A) program includes its downblending efforts as a separate category in DOE's annual budget requests to Congress; therefore, we include it as a separate category in this report.

<sup>c</sup>This figure includes \$16 million for physical protection upgrades at Mexico's Salazar and South Africa's Pelindaba sites, which were outside the scope of the goal.

DOE's GTRI and MPC&A exceeded their goals for the following key activities during the initiative:

**Removing or disposing of HEU and plutonium:** DOE's GTRI exceeded its goal for removing and disposing of HEU and plutonium. According to GTRI records, over the course of the initiative (April 2009 through December 2013), GTRI removed 1,581 kilograms of HEU and plutonium, exceeding its goal of 1,201 kilograms as reported in DOE's fiscal year

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2010 budget request.<sup>22</sup> GTRI removed all HEU from 11 countries and Taiwan under the initiative, bringing the number of countries where all HEU has been removed to a total of 26 plus Taiwan.<sup>23</sup> According to GTRI officials, these efforts involved close international cooperation with officials in the country from where the nuclear material was removed. Appendix IV provides additional details of all HEU and plutonium removed during the initiative, including the originating country, site, amount and type of nuclear material, and the month and year the material was removed. In addition, GTRI officials told us they disposed of additional materials by assisting in the downblending of 1.5 kilograms of HEU in Argentina in June 2013 and 33 kilograms of HEU in Kazakhstan in October 2011. According to GTRI records, it spent approximately \$531 million on these removal and disposition efforts.

In addition, GTRI in 2013 reported that it had disposed of other HEU by verifying the downblending of 1,240 kilograms of HEU in the United Kingdom and 112 kilograms of HEU in Japan. However, we did not include these as achievements toward its goal of removing or disposing of material because, according to GTRI officials, the downblending of HEU in the United Kingdom occurred many years prior to the initiative, GTRI was not able to determine that the downblending of material in Japan occurred during the initiative and, in both cases, it is unclear to what

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<sup>22</sup>For further details on our methodology on how we used budget requests to arrive at this and other goals, please see appendix I.

<sup>23</sup>Under the initiative, the 11 countries from which GTRI removed all HEU are Austria, Chile, Czech Republic, Hungary, Libya, Mexico, Romania, Serbia, Turkey, Ukraine, and Vietnam. GTRI considers all material removed from a country if less than 1 kilogram of HEU remains in the country.

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extent GTRI played an active role in identifying a disposition pathway for these materials.<sup>24</sup>

**Downblending HEU:** DOE's MPC&A exceeded its goal for downblending 2,700 kilograms of HEU. According to MPC&A officials, MPC&A verified the downblending of 4,900 kilograms of HEU to LEU in Russia during the initiative. MPC&A officials estimated they spent more than \$70 million on these efforts.

DOE did not achieve its goals for the following key activities during the initiative:

**Upgrading physical protection:** DOE did not achieve its goals for upgrading the physical protection of HEU and plutonium at 43 buildings. Specifically, according to MPC&A documents, MPC&A upgraded the physical protection for HEU and plutonium at 32 buildings. According to these officials, the upgrades of the 32 buildings were completed at three sites in Russia. MPC&A officials estimated they spent about \$33 million on these efforts. In addition, although it did not set a goal for this activity, according to GTRI officials, it completed physical protection upgrades at Mexico's Salazar site and continued work at South Africa's Pelindaba site during the initiative. The work at Pelindaba was completed in January 2015. GTRI reported it spent approximately \$16 million for these efforts.<sup>25</sup>

**Converting reactors:** GTRI did not achieve its goal to convert 34 foreign reactors from HEU to LEU during the initiative. Specifically, GTRI

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<sup>24</sup>More specifically, GTRI officials told us that the downblending of 1,240 kilograms of U.S.-origin nuclear material occurred at the United Kingdom's Dounreay facility in the 1980s and 1990s. GTRI officials told us that almost all of the HEU material downblended at Dounreay came from the Dounreay Fast Reactor, downblended in 1985; Germany's KNK-II fast breeder reactor prototype, downblended in March 1997 to 1998; and Germany's Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, downblended in 1993. GTRI officials stated that smaller amounts of this HEU were downblended from 1976 through 2008. In addition, GTRI was not able to confirm whether 112 kilograms of U.S.-origin HEU in Japan was downblended since the April 2009 start of the initiative. According to information GTRI provided, it did not spend funds on efforts identifying and confirming the disposition of the downblended material in the United Kingdom and Japan. In addition, we did not include 22 kilograms of HEU that GTRI removed from facilities within the United States during the initiative.

<sup>25</sup>In addition, according to NRC officials, some countries have implemented significant security upgrades using their own resources, in order to meet NRC's export licensing requirements.

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converted 23 foreign reactors, 11 fewer than its goal for conversions by the end of fiscal year 2013.<sup>26</sup> GTRI reported it spent approximately \$5 million on these efforts. Appendix V provides more details on reactor conversions during the initiative, including country, site, and date the conversion was completed or the reactor was verified as shut down.

GTRI officials told us in July 2014 that political and technical challenges have complicated efforts to convert research reactors and isotope facilities. For instance, according to these officials, delays in the development of LEU replacement fuel to power the European Union high-performance reactors and the development of LEU targets for medical isotope production processes have posed challenges in meeting goals but, according to GTRI officials, work continues to ensure that the objectives will be met as soon as possible.

DOD and other agencies also made contributions toward the initiative. For example, DOD officials reported that DOD contributed to the removal of nuclear material by (1) aiding in shipments of Russian warheads from deployed sites to more central repositories or to facilities for dismantlement and (2) providing physical protection upgrades and security efforts at sites during the initiative. DOD officials reported the agency spent \$178 million and \$78 million, respectively, in these areas, bringing the U.S. agency total initiative-related spending in the four key activities to about \$912 million. Moreover, as appendix III further details, DOE, DOD, and other U.S. agency officials responding to our data collection instrument indicated that about half of initiative-related spending was for efforts other than the four key activities supporting site lockdown programs to remove or secure vulnerable nuclear materials

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<sup>26</sup>As appendix I details, we excluded foreign reactors that had already been converted at the time that the initiative started, as well as two U.S. reactors converted during the time of the initiative, on which GTRI officials reported they spent \$17 million before inflation (or \$18 million in 2014 constant dollars). Without these adjustments, the goal using the fiscal year 2010 budget request as a basis would be 34 reactors converted. In March 2015, GTRI officials told us that this is an inaccurate way of measuring the program, as reactor conversions are long-lead projects and extremely complex technically, politically, and financially. Therefore, their goals are reevaluated annually to ensure that the budget for these activities is allocated appropriately to projects that can progress. GTRI's subsequent projections in its fiscal year 2011 and 2013 budget requests indicate downward estimates of the number of reactors to be converted by the end of fiscal year 2013. More specifically, in their fiscal year 2011 and 2013 budget requests, GTRI's goals for total reactor conversions by fiscal year 2013 were 96 and 88 reactors, respectively. GTRI's fiscal year 2012 budget request did not include a specific goal for reactor conversions.

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discussed in this report. DOE, DOD, and other U.S. agencies reported to us that their agencies spent more than \$1 billion on such activities. These activities included, for example, training on physical protection, protective force, and transportation security; material control and accounting training; and constructing nuclear centers of excellence worldwide.<sup>27</sup>

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## DOE Developed New Goals Since the Initiative for the Four Key Activities, but Challenges May Hamper Future Progress for Securing HEU and Plutonium

DOE has developed new goals since the end of the initiative for continued efforts related to the initiative's four key activities to help secure or remove HEU and plutonium. However, four challenges may hamper future progress: (1) access to some countries and sites may continue to be a challenge, (2) DOE and other U.S. agencies have not completed an inventory of U.S.-obligated plutonium overseas, (3) DOE has not prioritized its inventory list of HEU at foreign locations for removal or disposition, and (4) DOE and other agencies have not visited key sites in more than 20 years to determine whether U.S.-origin material on-site is adequately protected.

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## DOE Has Developed New Goals Since the Initiative for the Four Key Activities Going Forward

DOE has developed goals for all four key activities that are expected to result in securing or removing HEU and plutonium going forward since the initiative concluded in 2013. DOE included three of these goals in its fiscal year 2015 budget request. GTRI provided us with information regarding its goal for removing or disposing of HEU or plutonium. Table 2 shows DOE's goals for these activities, as well as its planned spending to achieve these goals.

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<sup>27</sup>We did not focus on or assess activities to consolidate materials in this report, although such activities would be included in the stated focus of the NSC's initiative—site lockdown programs to secure and remove HEU and plutonium—and NSC officials indicated in July 2014 that consolidation was a core effort of the initiative. This is because DOE did not set goals for consolidation activities or include any consolidation activities in its budget requests. In addition, DOE officials told us that the Russian sites of most interest for consolidating vulnerable nuclear materials were not under consideration for consolidation activities. DOE's MPC&A program supported consolidation efforts at two sites in Russia during the original initiative, though neither was completed during the initiative, and DOE officials told us that Russian officials informed them in December 2014 that any further work on these projects will be completed by Russia without U.S. assistance. DOE officials reported they had spent \$15 million on these consolidation activities during the initiative, which is accounted for in other initiative-related spending. Similarly, DOD contributed to a consolidation project in Russia by assisting in the shipment of HEU at an estimated cost of \$22 million, which is also captured in other initiative-related spending.

**Table 2: Department of Energy (DOE)’s Planned Spending by Four Key Activities and Other Related Activities from January 1, 2014 through September 30, 2019**

Dollars in millions		
Activity	Goal	Amount planned
HEU and plutonium removed or disposed of	1,029 kilograms <sup>a</sup>	\$517
HEU downblended	5,200 kilograms	\$31
Enhance physical protection at vulnerable sites	11 buildings	\$18
HEU reactors converted to LEU	27 foreign reactors	\$73
<b>Total</b>		<b>\$639</b>

Legend: HEU = highly enriched uranium; LEU = low-enriched uranium

Sources: GAO analysis of DOE’s Global Threat Reduction Initiative (GTRI) and Material Protection, Control and Accounting Program (MPC&A) data. | GAO-15-799

Note: Numbers rounded to nearest kilogram or millions of dollars.

<sup>a</sup>Goals for HEU and plutonium removed or disposed of are based on GTRI’s reporting to GAO and are for the period through December 2019; DOE’s fiscal year 2015 budget request states that GTRI’s goal is to remove 935 kilograms of vulnerable nuclear materials by the end of fiscal year 2019. Other goals are based on DOE’s fiscal year 2015 budget request and related planning documents and are through September 30, 2019. Because GTRI includes downblending as a disposition activity within its performance metric for removing or disposing of HEU and plutonium in DOE’s annual budget requests to Congress, we are including the material masses and spending for GTRI’s downblending in the removal and disposition category. By contrast, DOE’s MPC&A includes its downblending efforts as a separate category in DOE’s annual budget requests to Congress; therefore, we include it as a separate category in this report.

More specifically, DOE has developed the following goals since the initiative ended in 2013:

**Removing or disposing of HEU and plutonium:** According to DOE planning documents and information that department officials provided to us, GTRI’s goal is to remove or dispose of an additional 1,029 kilograms of fresh and spent HEU, as well as plutonium worldwide from 2014 to December 2019.<sup>28</sup> GTRI also specified that this 1,029 kilograms of HEU includes 2 kilograms of spent HEU to be downblended in Argentina and 3

<sup>28</sup>In DOE’s fiscal year 2009, 2010, 2011, 2014, and 2015 budget requests, DOE states its goal for this activity is the cumulative number of kilograms of HEU and plutonium “removed or disposed of.” Our review of these budget requests notes that its fiscal year 2015 budget request—but not in other years’ requests since 2009—DOE in accompanying text regarding the goal notes that it aims to “remove and/or confirm the disposition of...” such materials. For the purposes of this report, we note that the overall metric as stated in its budget requests from 2009 through 2015 is to remove or dispose of HEU or plutonium, and that this may include confirming the disposition of material in some cases.

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kilograms of spent HEU to be downblended in Indonesia, which would result in the elimination of HEU in both of those countries.<sup>29</sup> In 2014, GTRI removed 134 kilograms of HEU and plutonium. In fall 2014, GTRI gave us a list of nuclear materials it would like to address, either by removal or disposition. This list, which includes 2,259 kilograms of materials, far exceeds GTRI's 1,029 kilograms goal, but GTRI officials told us they believe 1,029 is a reasonable target for nuclear material removals during this period.

**Downblending HEU:** According to MPC&A's fiscal year 2015 budget request, MPC&A's goal was to support the downblending of 5,200 kilograms of HEU in Russia through fiscal year 2019. However, Russian officials decided in December 2014 to reduce DOE's scope of work in Russia and, at that time, announced that the downblending program would be discontinued.

**Upgrading physical protection:** According to MPC&A's fiscal year 2015 budget request, MPC&A had a goal of supporting physical protection upgrades at 11 buildings in Russia and completing those upgrades by the second quarter of fiscal year 2015. As of December 2014, MPC&A completed upgrades at 3 of these buildings. However, MPC&A officials told us that, because of Russian officials' decision in December 2014 to reduce DOE's scope of work in Russia, activities to support physical protection upgrades at the remaining 8 buildings at the site are to be completed by the Russians using Russian funds. Russian officials made no assurances as to the scope of work in completing these upgrades or adherence to DOE's original timelines.

**Converting reactors:** DOE's fiscal year 2015 budget request states that GTRI's goal is to convert 27 foreign research reactors and medical isotope production facilities to LEU by the end of fiscal year 2019.<sup>30</sup> GTRI officials told us in July 2014 that approximately 100 foreign civilian research reactors and isotope production facilities worldwide currently

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<sup>29</sup>GTRI aims to remove all HEU from an additional nine countries by December 2019.

<sup>30</sup>DOE's fiscal year 2015 budget request states it plans to convert 27 reactors or medical isotope production facilities by the end of fiscal year 2019. A November 2009 GTRI document presented to GAO notes that it plans to convert an additional 13 domestic U.S. reactors by September 2020. GTRI did not provide any further information regarding the number of foreign versus U.S. reactors planned for conversion by the end of fiscal year 2019.

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use HEU, with about two-thirds of those remaining reactors in Russia. GTRI officials gave us a list of 13 foreign reactors or medical isotope production facilities they plan to either convert or verify the shutdown of from 2014 through 2016.

In addition to DOE's goals for the four key activities associated with removing and securing HEU and plutonium since the initiative ended in 2013, other agencies have some plans going forward. Collectively, DOD, NRC, and State officials told us that they plan to spend \$27 million from 2014 through 2019 for initiative-related activities. For example, DOD officials cited no specific future goals but told us its Cooperative Threat Reduction program plans to spend \$4 million to complete nuclear material removals at certain Russian sites by dismantling nuclear submarines and consolidating the nuclear material at secure sites elsewhere in Russia. Officials from agencies participating in the initiative also stated that, in the future, the majority of expected spending is to be for efforts other than for the four key activities. Specifically, officials from DOE and other agencies told us that they plan to spend almost half, or about \$600 million of an estimated \$1.3 billion in planned spending from 2014 through 2019 for efforts other than the four key activities, such as, for example, training activities. For example, DOD officials told us that DOD's Cooperative Threat Reduction program plans to spend \$34 million to assist in developing nuclear security centers of excellence, which are centralized locations where countries or regions can send professionals for training in various aspects of nuclear security, such as physical protection best practices and emergency preparedness and response.

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### Challenges May Hamper Agencies in Four Key Ways

We identified four challenges that may hamper DOE and other agencies' abilities to meet their goals and maintain progress to secure HEU and plutonium going forward: (1) access to some countries and sites may continue to be a challenge, (2) DOE and other U.S. agencies have not completed an inventory of U.S.-obligated plutonium overseas, (3) DOE has not prioritized its inventory list of HEU at foreign locations for removal or disposition, and (4) DOE and other agencies have not visited key sites in more than 20 years to determine whether U.S.-origin material on-site is adequately protected.

### Access Challenges May Continue to Pose Concerns

The first challenge we identified that may hamper future progress is that U.S. agencies may continue to encounter resistance by major allied and other countries to allowing access to some sites and agreeing to remove or secure vulnerable nuclear materials. Some countries have declined to grant U.S. officials access to sites or have denied permission to return



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DOE and Other U.S. Agencies  
Have Not Completed an  
Inventory of U.S.-Obligated  
Plutonium Overseas

vulnerable nuclear materials during the initiative. DOE and other U.S. agency officials told us that they continue to work with countries to secure additional vulnerable materials. Further details are classified and thus were omitted from this version of the report.

The second challenge that may hamper future progress is that U.S. agencies may not have complete information about the locations of U.S.-obligated plutonium worldwide. In September 2011, we concluded that without an accurate inventory of U.S. nuclear materials—in particular, weapons-usable HEU and separated plutonium—the United States does not have sufficient assurances regarding the location of materials for accounting and control purposes.<sup>31</sup> As a result, we recommended that State, working with DOE and NRC, determine a baseline inventory of U.S.-obligated HEU and separated plutonium for those partners with which the United States has transferred material but does not have annual inventory reconciliation, and establish a process for conducting annual reconciliations of inventories of nuclear material on a facility-by-facility basis. DOE, NRC, and State did not agree with this recommendation,<sup>32</sup> but they have taken actions to partially implement it. Specifically, DOE completed an initial inventory of U.S.-origin HEU overseas, as published in a June 2013 GTRI report.<sup>33</sup> GTRI has stated

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<sup>31</sup>[GAO-11-920](#). The report further stated that without an accurate inventory of U.S. nuclear materials, including separated plutonium, the United States may not be able to monitor whether it is receiving the notifications it needs from partner countries to exercise its rights of approval regarding the transfer, retransfer, enrichment and reprocessing, and in certain cases, the storage of nuclear materials subject to nuclear cooperation agreement terms.

<sup>32</sup>As we reported in September 2011, DOE, NRC, and State asserted it was not necessary to implement GAO's recommendation that agencies undertake such an inventory reconciliation for reasons stated in their comments on our report, *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). However, we continue to stand by the recommendation because, as we reported, the U.S. government does not have an inventory of U.S. nuclear material overseas and is not able to identify where weapons-usable materials including HEU and plutonium reside, among other reasons. In addition, as we reported, because U.S. agencies do not have comprehensive knowledge of where U.S.-obligated material is located at foreign locations, it is unknown whether the United States is appropriately and fully exercising its rights of approval regarding the transfer, retransfer, enrichment and reprocessing, and storage of nuclear materials subject to nuclear cooperation agreement terms.

<sup>33</sup>See DOE, Global Threat Reduction Initiative, *"Reconciliation of U.S.-Origin Highly Enriched Uranium Exported to Foreign Countries for Civilian Use"* (June 2013). (C/FGI-MOD)

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DOE Has Not Developed a  
Prioritized List of HEU at  
Foreign Locations to Inform  
Removal or Disposition Efforts

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that “particularly troubling” is the high volume and rapid expansion of worldwide civilian plutonium inventories, which have grown by an additional 100,000 kilograms in the past 15 years to approximately 310,000 kilograms worldwide.<sup>34</sup> U.S. agencies have not, however, completed an inventory of all U.S.-obligated separated plutonium stocks worldwide to determine the amount and locations of potentially vulnerable plutonium that could be addressed in future DOE efforts. A May 2013 GTRI document noted it planned to account for all civilian plutonium inventories by the end of 2016. We continue to believe that an inventory of all U.S.-obligated plutonium overseas is necessary to both identify nuclear material and to account for and ensure that such material is protected in accordance with international physical security guidelines.

The third challenge that may hamper future progress is that DOE has not prioritized for return or disposition nuclear material stocks, including newly identified U.S.-origin HEU overseas from its recent accounting of U.S.-origin HEU overseas. As noted above, DOE completed an initial inventory of U.S.-origin HEU overseas in June 2013; however, to date, DOE has not prioritized this list to identify the most vulnerable U.S.-origin HEU overseas to prioritize for return or disposition. According to GTRI’s June 2013 report summarizing initial inventory information regarding U.S.-origin HEU at foreign locations, more than 13,000 kilograms of U.S.-origin HEU remain worldwide, including 3,526 kilograms of unirradiated or fresh U.S.-origin HEU and 1,771 kilograms of irradiated U.S.-origin HEU eligible for return.<sup>35</sup> GTRI officials have stated that its effort at accounting for U.S.-origin HEU overseas identified significant quantities of nuclear material that could be addressed going forward; its June 2013 report stated that it would begin prioritizing the removal or disposition of the most attractive nuclear material the study identified. However, as of March 2015, GTRI has not identified which stocks it believes are the most attractive and contain the most vulnerable materials and, therefore, should be priorities

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<sup>34</sup>Moreover, the 1995 Nuclear Proliferation Assessment Statement accompanying the U.S.-EURATOM nuclear cooperation agreement estimated that 250 tons of U.S.-obligated plutonium are planned to be separated from spent power reactor fuel in Europe and Japan for use in civilian nuclear energy programs in the next 10 to 20 years, and, as we found in September 2011, the United States would not be able to identify the European countries or facilities where such U.S. obligated material is located.

<sup>35</sup>See DOE, Global Threat Reduction Initiative, “*Reconciliation of U.S.-Origin Highly Enriched Uranium Exported to Foreign Countries for Civilian Use*” (June 2013). (C/FGI-MOD)

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for return or disposition.<sup>36</sup> In March 2015, GTRI officials told us that GTRI's priorities for U.S.-origin material, from highest to lowest priority, consist of (1) removing or confirming the disposition of as much excess fresh HEU as possible; (2) returning or confirming the disposition of U.S.-origin irradiated HEU that is eligible for return; and (3) working with international partners to develop disposition pathways for additional irradiated material that could be attractive to terrorists for a nuclear weapon.<sup>37</sup> However, as of May 2015, GTRI had neither provided GAO with a detailed or specific prioritized list of nuclear materials for return as noted in July 2014 and reaffirmed in January 2015, nor provided a time frame for doing so.

DOE's order on internal control calls for "processes for planning, organizing, directing, and controlling operations designed to reasonably assure that programs achieve intended results, and decisions are based on reliable data,"<sup>38</sup> and notably the initiative called for all vulnerable nuclear material to be secured, with a strategy to identify and prioritize the most vulnerable sites. In addition, Congress continues to express interest in securing the most vulnerable nuclear materials. Specifically, a committee of Congress in June 2013 requested that DOE, among other things, develop a new strategic plan to secure and dispose of nuclear

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<sup>36</sup>Our review found that 16 of 29 of GTRI's highest "1A" prioritized stocks in August 2010 were irradiated or "spent" HEU. In addition, the NSC's initiative document notes that sites containing at least 5 kilograms of irradiated HEU and any other material considered to not be self-protecting would be a focus of the initiative. In its July 2014 report to Congress, DOE notes GTRI targets material that is excess and particularly prone to theft or diversion, including irradiated fuel that may no longer be self-protecting. In addition, GTRI's June 2013 report identified 4,605 kilograms of U.S.-origin irradiated HEU as being ineligible for return to the United States, which it has not prioritized to determine the extent to which the program may wish to conduct additional analyses of disposition pathways to facilitate the return of such materials to the United States or prioritize them for disposition elsewhere.

<sup>37</sup>In addition to the initiative's definition of vulnerable nuclear material, DOE officials told us that, since any fresh HEU or separated plutonium is inherently attractive to terrorists and, therefore, vulnerable, the department would seek to remove any quantities of excess fresh HEU or plutonium when possible.

<sup>38</sup>DOE Order O 413.1B.

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DOE and Other Agencies Have Not Visited Key Sites in More Than 20 Years to Determine Whether U.S.-Origin Material On-Site Is Adequately Protected

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materials that pose the greatest terrorism risk to the United States.<sup>39</sup> Without an updated list of nuclear materials that prioritizes for returns or disposition, DOE and other U.S. agencies do not have reasonable assurance that they are prioritizing resources to identify, include, and address the most highly vulnerable and attractive nuclear materials that remain outside of the United States, and, where feasible, identify a final disposition pathway in the United States or elsewhere.

The fourth challenge that may hamper future progress is that DOE and other agencies have not visited key sites to ascertain whether U.S.-origin nuclear material is protected in accordance with international physical security guidelines. This is consistent with the findings in our September 2011 report,<sup>40</sup> which noted that U.S. interagency physical protection teams had not visited all partner facilities believed to contain Category I quantities of U.S.-origin nuclear material at least once every 5 years—an official interagency goal. As a result, we recommended in September 2011 that State work with other agencies to facilitate visits to sites that had not been visited and that are believed to hold Category I nuclear material. State did not agree with this recommendation,<sup>41</sup> but it has taken actions to implement it.<sup>42</sup> In addition, in our September 2011 report, we found that U.S. agencies did not have a formal process for coordinating

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<sup>39</sup>S. Rept. No. 113-47, to accompany S. 2145, Energy and Water Development Appropriation Bill, 2014. The report directs the National Nuclear Security Administration (NNSA) to submit by May 1, 2014, a new 4-year strategic plan to secure and dispose of remaining vulnerable nuclear and radiological materials that present the greatest terrorism risk to the United States.

<sup>40</sup>[GAO-11-920](#).

<sup>41</sup>In its response letter included in our September 2011 report, State noted that U.S. physical protection teams had been granted access to every site that they have requested access to under nuclear cooperation agreement consultation provisions currently in force, and that facilitating physical protection visits requested by DOE were State's current practice. State did not provide further information on why it disagreed with GAO's recommendation. However, as our report noted, U.S. physical protection teams had not visited all partner facilities believed to be holding Category I quantities of U.S. special nuclear material.

<sup>42</sup>We further noted in that report that the United States had met this goal during the period from 1987 through 2010 with respect to 2 countries, but it had not met it for 21 other countries believed to hold Category I quantities of U.S. nuclear material during the period. U.S. agencies have made progress in meeting this goal; our current review identified 7 countries that maintained Category I quantities of U.S.-origin HEU, and our review of U.S. agency physical protection records indicate U.S. teams visited those countries since March 2010.

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and prioritizing physical protection visits, and we recommended that DOE work with U.S. agencies to develop formal goals for and a process to determine which foreign facilities to visit in the future, and we noted the goals should be formalized and agreed to by all agencies. We additionally recommended that DOE work with other agencies to review performance information to determine which countries containing Category I U.S. nuclear material have been visited in the last 5 years and determine whether facilities not meeting international physical security guidelines were revisited in a timely manner. DOE did not agree with these recommendations either,<sup>43</sup> but it has taken actions to implement them.

In recent years, DOE has worked with U.S. agencies to develop a formal methodology to prioritize physical protection visits, as detailed in a September 2012 document.<sup>44</sup> These efforts notwithstanding, information regarding the security status of some sites storing U.S. nuclear materials remains unknown. Records of recent U.S. physical protection visits show that U.S. teams have not visited many sites believed to be storing Category I or Category II quantities of U.S.-origin HEU in more than 20 years to ascertain whether material there is being protected in

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<sup>43</sup>As we reported in September 2011, DOE in its comment letter stated that the formal goal of the program was to determine whether U.S.-obligated nuclear material at a partner country facility was being protected in accordance with international physical security guidelines. We noted in that report that this was the first time the goal was articulated to us as such. In addition, as we reported in September 2011, DOE in its comment letter further stated that it had established a process for coordinating and prioritizing visits. We noted in that report that in October 2009 a DOE Office of Nonproliferation and International Security official told us that it had formulated a list of 10 countries that contained U.S. nuclear material and were priorities for U.S. physical protection teams to visit. However, as we reported, the DOE official told us that DOE had not discussed this list with State or NRC or other agency officials, and it could not be considered an interagency agreed-upon list.

<sup>44</sup>DOE, Office of Nuclear Safeguards and Security, "U.S. Physical Protection Assessments Prioritization Methodology" (Washington, D.C.: September 2012). (Official Use Only/OUO)

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accordance with international physical security guidelines.<sup>45</sup> More specifically, we identified four Category I and seven Category II sites holding U.S.-origin HEU that U.S. interagency physical protection teams have not visited in at least 20 years. Collectively, these sites hold 2,261 kilograms unirradiated U.S.-origin HEU and 1,327 kilograms of irradiated U.S.-origin HEU.

An NRC official told us in March 2015 that any U.S. material exported to a partner country would be expected to be maintained in accordance with the international physical security guidelines NRC references in its regulations, and that NRC's regulations provide for the "continuing review" of previously exported material.<sup>46</sup> In addition, in March 2012, the DOE Deputy Administrator for Defense Nuclear Nonproliferation testified that DOE led U.S. interagency teams on visits to ensure that partner sites meet revision 5 of international physical security guidelines.<sup>47</sup> Without an assessment of the physical security conditions of the U.S.-origin nuclear material at these Category I and Category II facilities, DOE and U.S. agencies are not able to determine if this material is protected in accordance with international security guidelines. In addition, without information on this material, DOE and U.S. agencies lack reasonable assurance that they are removing or disposing of the most vulnerable

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<sup>45</sup>As noted elsewhere, GTRI targets material that is excess and particularly prone to theft or diversion, including spent fuel that may no longer be self-protecting, and NSC's initiative document notes that sites containing at least 5 kilograms of irradiated HEU and any other material considered to not be self-protecting would be a focus of the initiative. According to IAEA, as detailed in appendix II, fuel which by virtue of its original fissile material content is classified Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 100 rad/h at one meter unshielded. For the purposes of this report, we refer to irradiated material whose radiation level from the fuel exceeds 100 rad/h at one meter unshielded as "self-protecting," and irradiated material whose radiation level from the fuel no longer exceeds 100 rad/h at one meter unshielded as "not self-protecting."

<sup>46</sup> NRC regulations note that determinations regarding the adequacy of physical security measures are made on a countrywide basis and are subject to continuing review. 10 C.F.R. § 110.44 (2015). An NRC official told us that, for U.S. material exported under an earlier version of international physical security guidelines, the principle of continuing review means that partner countries are expected to maintain exported material in accordance with the version currently cited in NRC's regulations.

<sup>47</sup>Statement of Anne Harrington before the U.S. Senate Homeland Security and Governmental Affairs Committee, March 14, 2012.

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nuclear materials, in accordance with the stated goals of the president's initiative and the expressed interest of a committee of Congress.<sup>48</sup>

In addition to the challenges we identified above, as we reported in our August 2015 classified report, vulnerabilities remain worldwide after the conclusion of the initiative in December 2013. For example, our review of GTRI records indicates that about one-third of the nuclear material stocks prioritized for removal in 2010 have not been removed. We reviewed GTRI's August 2010 list of prioritized stocks for nuclear material removals and compared them with information regarding the nuclear materials returned by GTRI through January 2015. Of the 29 specific stocks of nuclear material deemed "1A" priorities for removal in August 2010,<sup>49</sup> GTRI has removed 18 as of January 2015, yet more than 1,000 kilograms of nuclear materials remain at sites that were priorities for removal and haven't been removed. In addition, records of recent years' U.S. physical protection visits continue to show that some foreign sites are not protected in accordance with the current international physical security guidelines. Our analysis of DOE documentation shows U.S. interagency physical protection teams made 53 assessments from April 2009 through March 2015 to observe and evaluate the physical protection afforded U.S.-origin nuclear material of 43 sites. Of these 43 sites, 32 sites—including 17 Category I sites, 10 Category II sites, and 5 Category III sites—were found to meet international security guidelines when they were assessed at the time of the initial visit. This represents improvement

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<sup>48</sup>S. Rept. No. 113-47, to accompany S. 2145, Energy and Water Development Appropriation Bill, 2014. The report directs NNSA to submit by May 1, 2014, a new 4-year strategic plan to secure and dispose of remaining vulnerable nuclear and radiological materials that present the greatest terrorism risk to the United States.

<sup>49</sup>According to GTRI documentation, priority levels are a measure of the overall risk based not only on the potential consequence of the material but also the current security and threat conditions the material is under. At the time GTRI developed the GTRI prioritization level by first determining the material attractiveness on-site, and then calculated a cumulative score from other prioritization factors, which included assessments of site security, the country threat environment, and the location. A material attractiveness level of 1A with a cumulative score from other threat factors of 0-6 would result in a 1A priority, while a material attractiveness level of 1B combined with a cumulative score from other factors of 4-6 would result in a 1B priority, for example.

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since our September 2011 report;<sup>50</sup> however, 6 Category I sites, 6 Category II sites, and 1 Category III site were found to not meet international physical security guidelines at the time of the initial visit. Additional details about this and other information regarding vulnerabilities that remain at the end of the initiative are classified and were omitted from this version of the report.

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## Conclusions

DOE has made progress under the President's 2009 initiative to remove HEU and plutonium from vulnerable sites, verify the downblending of HEU to LEU, physically protect vulnerable sites, and convert reactors and production facilities from HEU to LEU. Physical security is a sovereign nation responsibility and activity, and thus it is important that U.S. agencies coordinate and cooperate with these nations to gain access to overseas sites containing U.S.-origin nuclear material. However, while progress has been made, significant quantities of potentially vulnerable nuclear materials remain, and DOE and other U.S. agencies may have opportunities to improve their ability to ensure that as much of this nuclear material as possible can be secured.

We commend GTRI for taking the initiative to complete an initial inventory of U.S.-origin HEU overseas as we recommended in September 2011. However, GTRI's effort was limited to U.S.-origin HEU exported overseas; it does not account for U.S.-obligated plutonium overseas, as we recommended in the same report. An inventory of all U.S.-obligated plutonium overseas is important to both identify nuclear material and to account for and ensure that such material is protected in accordance with international physical security guidelines. Moreover, because DOE and U.S. agencies have not completed an inventory of all U.S.-obligated plutonium inventories overseas to determine the amount and locations of potentially vulnerable plutonium that could be addressed in future DOE efforts, it is possible that additional quantities of U.S.-obligated plutonium are vulnerable. As we recommended in September 2011, we continue to believe that U.S. agencies should complete an inventory of all U.S.-

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<sup>50</sup>See [GAO-11-920](#). In that report, we noted that, over the 17-year period from 1994 through 2010, U.S. interagency physical protection teams made 55 visits. Of the 55 visits, interagency physical protection teams found the sites met IAEA security guidelines on 27 visits, did not meet IAEA security guidelines on 21 visits, and the results of 7 visits were unknown because the physical protection team was unable to assess the sites or agency documentation was missing.



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obligated plutonium overseas to determine whether these nuclear materials are vulnerable, as well as to determine the amounts and locations of additional quantities of U.S.-obligated plutonium at worldwide sites that could be addressed in future DOE efforts.

DOE's GTRI has stated general priorities for returns and dispositions of HEU at foreign locations. In July 2014, GTRI officials stated they were undertaking an effort to prioritize information regarding inventories of HEU, to include U.S.-origin HEU identified in its June 2013 inventory reconciliation. However, as of May 2015, GTRI had not provided a detailed or specific prioritized list of nuclear materials, including recently identified U.S.-origin HEU at foreign locations, for return or disposition, to ensure that the most vulnerable nuclear materials are returned or provided a time frame for doing so. DOE's order on internal control calls for processes for planning, organizing, directing, and controlling operations to ensure that programs achieve intended results, and decisions are based on reliable data, and the initiative called for all vulnerable nuclear material to be secured, with a strategy to identify and prioritize the most vulnerable sites. Without an updated list of nuclear materials that prioritizes inventories for removal or disposition, DOE and other U.S. agencies do not have reasonable assurance that they are prioritizing resources to identify, include, and to address the most highly vulnerable and attractive nuclear materials that remain outside of the United States, and, where feasible, identify a final disposition pathway in the United States or elsewhere.

DOE has taken steps to develop a methodology to select and prioritize physical protection visits, as we had recommended in our September 2011 report. However, similar to our findings in our 2011 report, we found U.S. agency physical protection teams have not visited some Category I and Category II U.S.-origin nuclear material in at least 20 years to determine whether it is protected in accordance with international physical security guidelines. We do not dispute DOE's September 2012 methodology to prioritize physical protection visits. Notwithstanding the new methodology for prioritizing visits, until U.S. physical security teams visit Category I and Category II sites that have not been visited in many years, it will be difficult to know whether such materials are being adequately protected in accordance with current international physical security guidelines. We recognize that limited access to key major allied and other countries' sites has hampered U.S. agency efforts to secure all vulnerable nuclear materials worldwide. However, without information on the physical security of these sites, DOE will not have reasonable assurance that DOE or other U.S. agencies are removing or disposing of

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the most vulnerable nuclear materials, in accordance with the stated aims of the President's initiative and the expressed interest of a committee of Congress.

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## Recommendations for Executive Action

We are making two recommendations to ensure that the global initiative to remove and secure vulnerable nuclear materials achieves its stated goals of securing the most vulnerable nuclear materials and ensure that U.S. agencies are able to secure as much vulnerable nuclear material as possible:

- To ensure that the most vulnerable nuclear materials are given priority for removal or disposition, we recommend that the Secretary of Energy complete the prioritization for removal or disposition of inventories of identified nuclear materials at foreign locations, including recently identified stocks of U.S.-origin HEU at foreign locations, to determine priorities for efforts going forward.
- To ensure that Category I and Category II U.S.-origin nuclear material is protected in accordance with international physical security guidelines, we recommend that the Secretary of Energy work with U.S. agencies by requesting and, where feasible, undertaking physical protection visits at partner country sites that hold Category I and Category II quantities of U.S.-obligated nuclear material that have not been visited in more than 5 years—particularly those that have not been visited in 20 or more years.

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## Agency Comments and Our Evaluation

We provided a draft of this report to the Departments of Energy, Defense, and State and the Nuclear Regulatory Commission for their review and comment. DOE provided written comments, as reproduced in appendix VI. NRC provided a technical comment on the report, which we incorporated. DOD and State did not comment on our report.

In its comments, DOE agreed with our recommendations and provided information on specific actions taken and planned to address each recommendation, as well as timelines for their completion. Regarding our first recommendation that DOE complete its prioritization of nuclear material at foreign locations to identify the most vulnerable materials and ensure they are given priority for removal and disposition efforts, DOE stated that it was building on information provided in its 2014 report to Congress and would complete its revised prioritization list by September 30, 2015. Our second recommendation is that DOE request and, where feasible, undertake physical protection visits at partner country sites that

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hold Category I and Category II quantities of U.S.-obligated nuclear material that have not been visited in more than 5 years—particularly those that have not been visited in 20 or more years. DOE stated that it agrees with the recommendation but considers it closed, as it has continued to schedule and prioritize visits in an effort to achieve the goal of visiting all Category I sites every 5 years. However, we disagree with DOE’s assessment that the department has taken action to close this recommendation. As our report notes, we identified four Category I and seven Category II sites that have not been visited in at least 20 years. DOE’s comments note that, in some cases, visits have not been possible because access has been delayed or denied due to difficult political circumstances. However, as we note in the report, it is not clear that DOE has sought visits to all Category I and Category II sites that have not been visited in at least 20 years. In addition, DOE has not further identified which sites on this list or other Category I or Category II sites containing U.S. nuclear material that have not been visited in at least 5 years that it considers not feasible to visit due to political challenges. We continue to believe that our recommendation should be implemented to ensure that Category I and Category II U.S.-origin nuclear material is protected in accordance with international physical security guidelines.

In its letter DOE also stated that our evaluation provides a limited view of the physical protection activities involved in the initiative to secure all vulnerable nuclear materials around the world in 4 years, and that our characterization of “Other” to capture financial data for all other MPC&A activities could be misleading as the category of “Other” encompasses a broad scope of technical efforts that are nonetheless critical components of the nonproliferation mission. We disagree that our evaluation provides a limited view of activities under the initiative to secure vulnerable nuclear materials. As our report notes, the initiative’s focus is on programs to secure vulnerable nuclear materials, specifically site lockdown programs. We further note that our report focuses on four key activities to secure or remove HEU or plutonium: (1) removing or disposing of HEU and plutonium to secure locations in the United States or elsewhere; (2) downblending HEU to LEU; (3) upgrading the physical protection of HEU and plutonium at vulnerable sites; and (4) converting nuclear reactors and associated facilities that use HEU to LEU. Our report provided additional information regarding agency-reported spending for activities that were not among these four key activities as “other” spending. DOE cites other activities such as sustainability and training as being critical components of the nonproliferation mission. We do not disagree. However, as our report notes, in accordance with the initiative’s stated focus of site lockdown programs to protect vulnerable nuclear materials, activities such

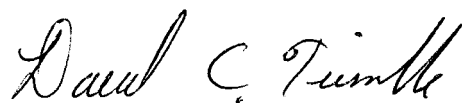
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as MPC&A sustainability activities—such as support for the maintenance, repair, and logistical services and spare equipment for the improved security systems—is beyond the scope of the initiative’s stated focus of site lockdown programs as well as this report.

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We are sending copies of this report to the appropriate congressional committees; the Secretaries of Defense, Energy, and State; the Chairman of the NRC; and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report or need additional information, please contact me at (202) 512-3841 or [trimbled@gao.gov](mailto:trimbled@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors are listed in appendix VII.



David C. Trimble  
Director, Natural Resources and Environment

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# Appendix I: Objectives, Scope, and Methodology

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This report: (1) assesses the extent to which the Department of Energy (DOE) achieved its goals associated with the 2009 initiative's four key activities of removing, downblending, and upgrading the physical protection of highly enriched uranium (HEU) and plutonium, and converting facilities that use HEU, and (2) examines DOE's goals since the end of the initiative associated with the four key activities and identifies and assesses challenges, if any, that may limit DOE's ability to secure as much vulnerable nuclear material as possible.

To conduct this work, we reviewed relevant documents and interviewed federal officials responsible for implementing the initiative. In particular, to assess the extent to which DOE achieved its goals associated with the initiative's four key activities, we reviewed the National Security Council's (NSC) interagency strategy and the document it circulated to agencies in 2011 to identify the primary objectives of the initiative and how DOE and participating federal agencies were expected to contribute in meeting these objectives. We also reviewed DOE's 2009 classified plan and fiscal year 2010 budget request—released in May 2009—to identify the goals that DOE had established at the initiative's start for contributing to the initiative's four key activities. Because the key activities associated with removing and securing HEU and plutonium are primarily undertaken by DOE, we focused on DOE's contributions but also included information regarding the contributions of other federal agencies involved in the initiative, as appropriate. In particular, we relied on DOE's performance metrics and goals for removing, downblending, and physically protecting nuclear materials, and converting reactors and production facilities from HEU to low-enriched uranium (LEU) as presented in its fiscal year 2010 budget request to assess progress toward achieving goals. We used DOE's fiscal year 2010 budget request to identify the goals that DOE had established at the initiative's start for contributing to the four key activities because it was issued in May 2009, 1 month after the start of the initiative and, in the absence of other annually published forward-looking information since the initiative's start, we identified it as a reasonable indicator of DOE's expectations and goals to be accomplished in the initiative.

We interviewed officials from DOE, the Department of Defense (DOD), the Nuclear Regulatory Commission (NRC), and the Department of State (State) and discussed these issues with NSC officials to determine the extent to which these agencies contributed to the initiative and their plans going forward. Through these interviews, we identified challenges these agencies confronted during the initiative and the challenges that may lie ahead. We also sent a data collection instrument to relevant offices in

DOE, DOD, NRC, and State to obtain additional information on each agency's contribution to the initiative, how much each agency spent on these efforts, and how they plan to contribute to them. We received responses from each of the agencies and offices that we sent the data collection instrument to, namely, DOE's Global Threat Reduction Initiative (GTRI), DOE's Material Protection, Control and Accounting (MPC&A) program, DOD's Cooperative Threat Reduction program, State, and NRC. We analyzed the completed responses to determine how much agencies spent from May 2009 through December 2013 and to collect agency estimates of spending for fiscal years 2014 through 2019. We followed up with agency officials for clarification on questions related to the data as necessary. While the data collected generally tracked spending by fiscal year, they do not track completely with the time frame of the initiative, which ran from April 2009 through December 2013. To address this, we divided the fiscal year 2009 budget figures in half to account for the 6 months in calendar year 2009 that were a part of the initiative (from April 2009 through September 2009). We did this for all agencies except GTRI, which provided us with figures pulled from its G2 Financial Management System that officials said were specific to the months and years of the initiative. In addition, we accounted for the 3 months of fiscal year 2014 that were a part of the initiative (i.e., October 2013 through December 2013) by dividing the fiscal year 2014 spending figures by 4 and including one-fourth of those figures in each agency's totals for initiative spending, with the exception of GTRI. Although this effort is intended to better capture the amount of spending during the specific time frames of the initiative, it is unclear whether the spending was distributed equally among the months of the fiscal years. Therefore, the numbers that we are using are estimates. We adjusted the data for inflation, and all data are in 2014 dollars unless otherwise noted. To assess the reliability of the spending data, we manually tested it for missing values, obvious errors, or outliers. We then compared the data with related budget information available in the agencies' budget requests. We also included questions in our data collection instrument and received responses regarding how agencies compiled the data and maintained their data quality and data systems, and we interviewed knowledgeable agency officials to discuss the data. Through these efforts, we determined the data were sufficiently reliable for the purposes of this report.

We undertook additional efforts to specifically assess each of the four key activities as follows:

- For removing or disposing of HEU or plutonium,<sup>1</sup> we reviewed records from GTRI of nuclear materials returned, plans for future repatriation of remaining nuclear materials, the estimated amounts of remaining nuclear materials, and future priorities. We focused specifically on GTRI records because GTRI is the program chiefly responsible for such activity. We compared these efforts with goals achieved during the initiative to determine the amounts already removed and disposed of, and we interviewed GTRI officials to discuss these activities, as well as plans and goals for removals going forward. To determine the goals GTRI had for removals and dispositions, we reviewed the goals for removals and dispositions from its fiscal year 2010 budget request and subtracted the fiscal year 2013 goal for removal from the amount of nuclear material GTRI reported it had removed in fiscal year 2009 according to its fiscal year 2011 budget request. We subtracted the amount that GTRI reported it had removed between April 2009 and September 2009 to avoid double counting that figure. We also included removals that GTRI made in the 3 months beyond the end of fiscal year 2013 to try to better capture activities during the initiative itself, which ended in December 2013.
- For downblending, we reviewed DOE documentation of activities in support of downblending HEU and interviewed DOE's MPC&A officials about these efforts. To determine the amount of HEU planned for downblending during the initiative, we used the fiscal year 2010 budget request numbers. We subtracted 12,600 kilograms (the amount for fiscal year 2010 that began on October 1, 2009) from 15,300 kilograms (the amount targeted for fiscal year 2013, which concluded on September 30, 2013) to arrive at 2,700 kilograms as an estimate for amount planned for downblending during the initiative.
- For physical protection, we reviewed DOE information regarding buildings containing HEU or plutonium secured during the initiative, as well as information regarding plans going forward, including DOE information regarding the number of buildings secured at the start of

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<sup>1</sup>Our review indicates that both MPC&A and GTRI track and maintain reporting regarding downblending efforts. Because GTRI considers the downblending efforts it is involved in as a disposition activity within its performance metric for removing or disposing of HEU and plutonium in DOE's annual budget requests to Congress, we are including the material volumes and spending for GTRI's downblending in the removal and disposition category. By contrast, DOE's MPC&A includes its downblending efforts as a separate category in DOE's annual budget requests to Congress, therefore, we include it as a separate category in this report.

the initiative and DOE's fiscal year 2010 budget request. We compared the records with goals achieved during the initiative and interviewed DOE officials to discuss these activities, as well as plans and goals going forward.<sup>2</sup> With regard to spending on this activity, MPC&A provided us with updates to the spending data they originally gave us in order to better accommodate the initiative's activities as we describe them. Specifically, in the updated data, officials reallocated spending that they had originally categorized as supporting physical protection into the "other" category, which includes spending on efforts that are not among the four key activities of the initiative. According to MPC&A officials, the reallocated figures actually covered activities related to material control and accounting, which is not included in the four key activities.

- For conversion of reactors from HEU to LEU, we reviewed lists of planned and completed reactor conversions from GTRI, as GTRI is the lead program for this activity. We compared the lists with goals achieved during the initiative and interviewed GTRI officials to discuss these activities, as well as any plans and goals for reactor conversions going forward. To determine the goal for foreign reactor conversions during the initiative, we reviewed the fiscal year 2010 budget request and subtracted the target for foreign reactor conversions for fiscal year 2013 from the number of conversions completed in fiscal year 2008. We excluded foreign reactors that had already been converted at the time that the initiative started, as well as two U.S. reactors converted during the time of the initiative, on

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<sup>2</sup>In accordance with the initiative's stated focus of site lockdown programs to protect vulnerable nuclear material, this report focuses on the completion of physical upgrades at vulnerable sites. We note that DOE's MPC&A budget requests for MPC&A activities during the initiative cite completed upgrades as a performance goal. Once building upgrades are complete, MPC&A shifts its focus to sustainability activities that include support for maintenance, repair, and logistical services and spare equipment for the improved security systems. However, such activities are generally beyond the scope of the initiative's stated focus of site lockdown programs, as well as that of this report, as the original NSC initiative and the subsequent document circulated by NSC in 2011 to U.S. agencies indicate that the initiative aims for HEU and plutonium to be physically secured in accordance with international physical security guidelines. MPC&A officials told us that these guidelines provide a useful tool in discussing approaches to upgrades, but that MPC&A's intent is to reinforce a balanced approach between technology and the "human element." As a result, MPC&A's approach includes, among other things, protective force and material control and accounting aspects of nuclear security, including the supply of radiation portal monitors, tamper indicating devices, and waste stream monitoring. In addition, MPC&A officials told us that unlike international physical security guidelines, MPC&A does not focus on mitigation of the threat of sabotage.



which GTRI officials reported they spent \$17 million before inflation (or \$18 million in 2014 constant dollars). Without these adjustments, the goal using the fiscal year 2010 budget request as a basis would be 34 reactors converted. We then reviewed other DOE documents to ensure that we addressed foreign conversions that were completed between the start of fiscal year 2009 in October 2008 and the start of the initiative in April 2009. We then reviewed DOE priority lists to determine the number of U.S. reactors that were converted and those that awaited conversion, in order to ensure that we did not include those in the goal for the number of foreign reactors converted during the initiative.

We did not focus on consolidation activities in this report, although such activities would be included in the stated focus of the NSC's initiative—site lockdown programs to secure and remove HEU and plutonium—and NSC officials indicated in July 2014 that consolidation was a core effort of the initiative. We are not assessing consolidation activities under the initiative because DOE neither set goals for consolidation activities, nor did it include any in its budget requests.

To examine DOE's goals associated with the four key activities since the end of the initiative, and to assess any challenges that may limit DOE's ability to secure as much vulnerable nuclear material as possible, we collected and analyzed other information where available. Specifically, to identify goals going forward after the initiative concluded in December 2013, we reviewed the DOE's performance metrics and goals as presented in its fiscal year 2015 budget request issued in March 2014, as well as other information supplied by DOE.<sup>3</sup> We identified and analyzed DOE and other U.S. agency information regarding its programs for ensuring that U.S.-nuclear materials are physically protected consistent with international security guidelines at foreign locations, and we reviewed DOE information regarding planned nuclear material removals and dispositions to identify and assess any challenges that may limit DOE's ability to secure as much vulnerable nuclear material as possible. To provide information about any vulnerabilities that may pose challenges that remained at the end of the initiative, we analyzed U.S. government

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<sup>3</sup>More specifically, with respect to the number of reactors to be converted going forward, we relied on information reported in DOE's fiscal year 2015 budget justification, which noted that it aims to complete the conversion of an additional 4 reactors in fiscal year 2015 and an additional 23 research reactors and medical isotope production facilities by the end of fiscal year 2019.

data sources. For example, we compared DOE's August 2010 list of HEU and plutonium for which DOE set a priority for removal or disposition under the initiative to DOE records of HEU and plutonium removals and dispositions to determine how much of the prioritized nuclear material remained in vulnerable locations to be addressed going forward. We also reviewed records of U.S. physical protection visits to determine whether sites with U.S.-origin HEU were following international physical protection guidelines to secure the material. We reviewed previous GAO reports to identify and assess U.S. agency progress in implementing recommendations aiming to improve agency planning and oversight of vulnerable nuclear materials. We reviewed inventory information regarding U.S.-origin HEU overseas, in particular GTRI's June 2013 report, *Reconciliation of U.S.-Origin Highly Enriched Uranium Exported to Foreign Countries for Civilian Use*, and we reviewed other information, as available, to determine disposition plans for these nuclear materials. We reviewed current U.S. agency criteria for the removals of various types of nuclear materials and returns of such materials to the United States, and we compared them with DOE records to identify instances in which proposed returns of nuclear materials exceed or differ from planned for types or quantities. We interviewed officials from DOE, DOD, NRC, and State to learn more about how they plan to contribute to the key activities going forward, as well as challenges that may lie ahead. We visited DOE's Savannah River Site to meet with officials responsible for nuclear material returns made under the initiative. We also visited key sites in three countries that hold or held U.S.-origin HEU and conducted interviews with foreign country representatives to identify any concerns regarding DOE and U.S. agencies' ability to return the most vulnerable nuclear materials in accordance with initiative aims. We prepared and distributed a standard set of questions to foreign government officials from countries we did not visit; however, we did not use information obtained through these question sets as our response rate was low. Specifically, of the 14 countries that received the survey, 5 responded to the questions.

We conducted this performance audit from February 2014 to September 2015 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.

# Appendix II: International Physical Security Guidelines for the Categorization of Nuclear Material

The International Atomic Energy Agency's (IAEA) INFCIRC/225/Revision 5 international physical security guidelines document provides the basis by which the United States and other countries generally classify the categories of physical protection that should be afforded nuclear material, based on the type, volume, and disposition of the nuclear material. Table 3 lists the material category according to IAEA's international physical security guidelines.

**Table 3: Categorization of Nuclear Material According to International Atomic Energy (IAEA) Physical Security Guidelines, Revision 5**

Material	Form	Category I	Category II	Category III
Plutonium	Unirradiated	2 kilograms or more	Less than 2 kilograms but more than 500 grams	500 grams or less but more than 15 grams
Uranium-235 ( <sup>235</sup> U)	Unirradiated			
	(a) Uranium enriched to 20% <sup>235</sup> U or more	(a) 5 kilograms or more	(a) less than 5 kilograms but more than 1 kilogram	(a) 1 kilogram or less but more than 15 grams
	(b) Uranium enriched to 10% <sup>235</sup> U but less than 20% <sup>235</sup> U		(b) 10 kilograms or more	(b) less than 10 kilograms but more than 1 kilogram
	(c) Uranium enriched above natural, but less than 10% <sup>235</sup> U			(c) 10 kilograms or more
Uranium-233 ( <sup>233</sup> U)	Unirradiated	2 kilograms or more	Less than 2 kilograms but more than 500 grams	500 grams or less but more than 15 grams
Irradiated fuel (The categorization of irradiated fuel in the table is based on international transport considerations. The state may assign a different category for domestic use, storage, and transport taking all relevant factors into account.)			Depleted or natural uranium, thorium or low enriched fuel (less than 10% fissile content)	

Source: IAEA, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities," (IAEA INFCIRC/225/Revision 5 (2011)). | GAO-15-799

Note: According to IAEA, although this level of protection is recommended, it would be open to states, upon evaluation of the specific circumstances, to assign a different category of physical protection. Other fuel which by virtue of its original fissile material content is classified Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 100 rad/h at one meter unshielded. For the purposes of this report, we refer to irradiated material whose radiation level from the fuel exceeds 100 rad/h at one meter unshielded as "self-protecting," and irradiated material whose radiation level from the fuel no longer exceeds 100 rad/h at one meter unshielded as "not self-protecting."

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# Appendix III: Agencies' Spending to Secure Nuclear Materials under the Global Initiative to Secure Vulnerable Nuclear Materials

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We distributed a data collection instrument to the Department of Energy's (DOE) Global Threat Reduction Initiative (GTRI), DOE's Material Protection, Control and Accounting program (MPC&A), the Department of Defense's (DOD) Cooperative Threat Reduction program, the Department of State, and the Nuclear Regulatory Commission to ascertain what initiative-related work agencies performed and how much that work cost. To that end, the data collection instrument asked agencies to provide a yearly breakdown of all initiative-related spending from fiscal year 2009 through fiscal year 2014, including what work that spending supported, where that work occurred, and how much it cost. The data collection instrument also included questions regarding what agencies planned to spend from 2015 through 2019, and the projects and locations that the spending is expected to support. The data collection instrument also included questions regarding whether agencies had conducted assessments of their data reliability, if they had found any material errors in these assessments, whether the spending figures they were providing were exact or estimates, and—if applicable—how they arrived at the estimates.

Our analysis of these data indicates that agencies spent over \$1.9 billion in the four key areas of removing, downblending, physically protecting nuclear materials, and converting reactors and facilities that operate on highly enriched uranium (HEU) to low-enriched uranium (LEU), as well as on associated efforts such as training from April 2009 through December 2013. MPC&A spent the most among agencies we surveyed, with over \$1 billion spent, mainly on training and other initiative-related activities that fell outside the scope of the four key activities addressed in this report. GTRI spent the next greatest amount, with \$553 million, mainly for removals of vulnerable nuclear materials. DOD's Cooperative Threat Reduction program spent about \$329 million. The total amount of spending during the initiative is laid out by agency and activity in table 4 below.

**Appendix III: Agencies' Spending to Secure Nuclear Materials under the Global Initiative to Secure Vulnerable Nuclear Materials**

**Table 4: Global Nuclear Security Initiative Reported Spending by Agency and Activity, April 2009 through December 2013**

Dollars in millions (fiscal year 2014 dollars)

Agency/office	Activity					Total
	Remove	Downblend	Physically protect	Convert	Other <sup>a</sup>	
GTRI	\$531	0	\$16	\$5	0	<b>\$553</b>
MPC&A	0	\$70	\$33	0	\$1,024	<b>\$1,127</b>
CTR	\$78	0	\$178	0	\$74	<b>\$329</b>
NRC	0	0	0	0	\$0.1	<b>\$0.1</b>
State	0	0	0	0	\$0.2	<b>\$0.2</b>
<b>Total</b>	<b>\$609</b>	<b>\$70</b>	<b>\$227</b>	<b>\$5</b>	<b>\$1,098</b>	<b>\$2,010</b>

Legend: GTRI = Global Threat Reduction Initiative, MPC&A = Material Protection Control and Accounting, CTR = Cooperative Threat Reduction, NRC = Nuclear Regulatory Commission, State = Department of State

Source: GAO analysis of agencies' data, as reported in their responses to GAO's data collection instrument. | GAO-15-799

Note: Totals may not add due to rounding.

<sup>a</sup>"Other" includes such activities as the building of Nuclear Security Centers of Excellence and training of various site-related personnel. It also includes about \$15 million in MPC&A consolidation activities and \$22 million in DOD consolidation activities.

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# Appendix IV: Global Threat Reduction Initiative Types of Nuclear Material Return Programs, and Sites, Amounts, and Types of Vulnerable Nuclear Materials Returned

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Over the course of the initiative to secure vulnerable nuclear materials, the Department of Energy's (DOE) Global Threat Reduction Initiative (GTRI) removed highly enriched uranium (HEU) and plutonium from around the world, under what may be called the U.S.-origin nuclear material return program, the Russian-origin nuclear material return program, and the Gap nuclear material return program. More specifically,

**U.S.-origin nuclear material return program.** In May 1996, DOE announced it would create a program to allow certain U.S.-origin nuclear materials from Training, Research, Isotope General Atomic (TRIGA) and Material Test Reactor (MTR) reactors, as well as target material containing uranium enriched in the United States, to be returned the United States, subject to certain criteria. The February 1996 Final Environmental Impact Statement conducted to consider the potential environmental impacts of the program noted that fresh, unirradiated HEU would be eligible to return under the proposed program, as well as spent nuclear HEU and in some cases low-enriched uranium (LEU).<sup>1</sup>

**Russian-origin nuclear material return program.** A May 2004 government-to-government agreement between the United States and Russia established the program that returns Russian-origin material to Russia with U.S. government assistance. According to GTRI officials, Russia performs any necessary environmental reviews to facilitate those returns to Russian sites.

**Gap nuclear material return program.** In October 2007, a Secretary of Energy policy memo established the program to provide for the return to the United States of other types of spent nuclear materials not covered in the U.S.-origin nuclear material return program, if the material poses a threat to national security, is susceptible to use in an improvised nuclear device, presents a high risk of terrorist theft, and has no other reasonable pathway to assure security from theft or diversion.

Table 5 below lists all removals over the course of the initiative, the site the nuclear materials were removed from, the amount removed, the type of nuclear material, the month and year of removal, and whether the

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<sup>1</sup>See DOE, "Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel" (DOE/EIS-0218F, February 1996).

**Appendix IV: Global Threat Reduction Initiative  
Types of Nuclear Material Return Programs,  
and Sites, Amounts, and Types of Vulnerable  
Nuclear Materials Returned**

return was made under the U.S.-origin, Russian-origin, or Gap nuclear material program.

**Table 5: Global Threat Reduction Initiative Removals of HEU and Plutonium, April 2009 through December 2013**

<b>Country</b>	<b>Site</b>	<b>Amount (in kilograms)</b>	<b>Type of nuclear material</b>	<b>Removal month, year</b>	<b>Program</b>
Kazakhstan	Alatau	73.7	Spent HEU	May 2009	Russian
Italy	JRC	29	Plutonium	May 2009	Gap
Australia	HIFAR	14.6	Spent HEU	May 2009	U.S.
Romania	SSR Pitesti	30.1	Fresh HEU	June 2009	Russian
Romania	Magurele	23.7	Spent HEU	June 2009	Russian
Hungary	BRR	18	Fresh HEU	July 2009	Russian
Taiwan	ZPRL	4.8	Spent HEU	September 2009	U.S.
Poland	Maria	187	Spent HEU	October 2009	Russian
Libya	IRT-1	5.2	Spent HEU	December 2009	Russian
Japan	JMTRC	5	Spent HEU	January 2010	U.S.
Israel	IRR-1	12.4	Spent HEU	January 2010	U.S.
Turkey	TR-2	5.3	Spent HEU	January 2010	U.S.
Poland	Maria	137.4	Spent HEU	March 2010	Russian
Chile	Rech-2	0.3	Fresh HEU	March 2010	Gap
Chile	Rech-2	4.3	Spent HEU	March 2010	Gap
Chile	Rech-1	13.6	Spent HEU	March 2010	Gap
Italy	JRC	4.9	Fresh HEU	March 2010	Gap
Ukraine	Kiev	55.9	Spent HEU	May 2010	Russian
Poland	Maria	43.5	Spent HEU	May 2010	Russian
Czech Republic	REZ	12	Fresh HEU	June 2010	Russian
United Kingdom	Dounreay	3.7	Fresh HEU	August 2010	Gap
Poland	Maria	43.5	Spent HEU	August 2010	Russian
Belarus	Pamir	41	Spent HEU	October 2010	Russian
Poland	Maria	43.5	Spent HEU	October 2010	Russian
Italy	JRC	3.4	Plutonium	October 2010	Gap
Belgium	BR-2	12.7	Fresh HEU	October 2010	Gap
Canada	PTR	1.4	Spent HEU	October 2010	U.S.
Belarus	Pamir	47	Fresh HEU	November 2010	Russian
Ukraine	Kharkiv	16	Fresh HEU	December 2010	Russian
Ukraine	Sevastopol	25	Fresh HEU	December 2010	Russian
Ukraine	Kiev	9.7	Fresh HEU	December 2010	Russian
Serbia	Vinca	13.1	Spent HEU	December 2010	Russian

**Appendix IV: Global Threat Reduction Initiative  
Types of Nuclear Material Return Programs,  
and Sites, Amounts, and Types of Vulnerable  
Nuclear Materials Returned**

<b>Country</b>	<b>Site</b>	<b>Amount (in kilograms)</b>	<b>Type of nuclear material</b>	<b>Removal month, year</b>	<b>Program</b>
South Africa	SAFARI	5.8	Spent HEU	August 2011	U.S.
Canada	Slowpoke	0.9	Spent HEU	September 2011	U.S.
Mexico	Salazar	5.3	Fresh HEU	February 2012	U.S.
Ukraine	Kharkiv	108.6	Fresh HEU	March 2012	Russian
Mexico	Salazar	5.4	Spent HEU	March 2012	U.S.
Sweden	Studsvik	3.3	Plutonium	March 2012	Gap
Ukraine	Kiev	19.4	Spent HEU	March 2012	Russian
France	Cerca	66.1	Fresh HEU	March 2012	Gap
Uzbekistan	INP	36.4	Spent HEU	August 2012	Russian
Australia	HIFAR	2.3	Fresh HEU	August 2012	Gap
Poland	Maria	27	Fresh HEU	September 2012	Russian
Poland	Maria	61.9	Spent HEU	September 2012	Russian
Canada	NRU	1.8	Spent HEU	September 2012	U.S.
Italy	Avagadro	0.2	Spent HEU	December 2012	U.S.
Uzbekistan	INP	36.4	Spent HEU	October 2012	Russian
Canada	NRU	3.4	Fresh HEU	December 2012	Gap
Austria	TRIGA II	1.2	Spent HEU	December 2012	U.S.
Hungary	INP	16.5	Fresh HEU	December 2012	Russian
Czech Republic	Rez	68.1	Spent HEU	March 2013	Russian
France	Cerca	53.1	Fresh HEU	April 2013	Gap
Vietnam	Dalat	11.6	Spent HEU	July 2013	Russian
Italy	Various	10.6	Fresh HEU	August 2013	Gap
Hungary	BRR	49.2	Spent HEU	November 2013	Russian
Canada	Various	46.5	Fresh HEU	December 2013	Gap

Legend: HEU = highly enriched uranium

Source: GAO analysis of Global Threat Reduction Initiative data. | GAO-15-799



# Appendix V: Foreign Reactor Conversions and Shutdowns from May 2009 through December 2013

Over the course of the initiative, the Department of Energy's (DOE) Office of Global Threat Reduction Initiative (GTRI) helped convert highly enriched uranium (HEU) reactors to low-enriched uranium (LEU), confirmed the shutdown of additional HEU reactors, and converted the production of medical isotope facilities utilizing HEU processes. Table 6 lists the 23 reactors and medical isotope production facilities converted from HEU to LEU or shut down during the course of the initiative, including the country and facility containing the facility.

**Table 6: Reactors and Facilities Converted from HEU to LEU or Shut Down during the Global Nuclear Security Initiative, April 2009 through December 2013**

Month and year	Country	Facility	Site	City	Comments and conversion status
March 2009	Bulgaria	IRT-2000	Institute for Nuclear Research and Nuclear Energy	Sofia	Shutdown prior to conversion
September 2009	Hungary	BRR	Atomic Energy Research Institute	Budapest	Full conversion
February 2010	Russia	PhS-4 (FS-4)	IRM/ENTEK	Zarechniy	Shutdown prior to conversion
February 2010	Russia	PhS-5 (FS-5)	IRM/ENTEK	Zarechniy	Shutdown prior to conversion
February 2010	Russia	STRELA	IPPE	Obninsk	Shutdown prior to conversion
March 2010	Japan	KUR	Kyoto University	Kumatoricho, Osaka	Full conversion
April 2010	Chile	RECH-2 Research Reactor	Lo Aguirre Nuclear Centre	Santiago	Shutdown prior to conversion
December 2010	China	MNSR-SD	Shandong Geology Bureau	Jinan	Shutdown prior to conversion
April 2011	Czech Republic	REZ 10 MW Research Reactor	Nuclear Research Institute	Rez	Full conversion
June 2011	Russia	BR-10	IPPE	Obninsk	Shutdown prior to conversion
June 2011	Russia	MR reactor	MR reactor		Shutdown prior to conversion
December 2011	Canada	Slowpoke Halifax	Dalhousie University	Halifax	Shutdown prior to conversion
March 2012	Japan	YAYOI	University of Tokyo	Tokyo	Shutdown prior to conversion
March 2012	Japan	MITI Standard Pile	National Metrology Institute of Japan	Tsukuba	Shutdown prior to conversion
May 2012	Russia	TIBR	VNIEF	Sarov	Shutdown prior to conversion

**Appendix V: Foreign Reactor Conversions and  
Shutdowns from May 2009 through December  
2013**

<b>Month and year</b>	<b>Country</b>	<b>Facility</b>	<b>Site</b>	<b>City</b>	<b>Comments and conversion status</b>
August 2012	Netherlands	LFR	Nuclear Research & Consultancy Group	Petten	Shutdown prior to conversion
September 2012	Poland	Maria ZUOP Research Reactor	Institute of Atomic Energy	Otwock-Swierk	Full conversion
October 2012	Kazakhstan	VVR-K CA	Institute of Nuclear Physics	Alatau	Full conversion
November 2012	Russia	RF-GS	IPPE	Obninsk	Shutdown prior to conversion
February 2013	India	Apsara	Bhabha Atomic Energy Centre	Trombay	Shutdown prior to conversion
March 2013	China	MJTR	Nuclear Power Institute of China	Leshan	Full conversion
March 2013	United Kingdom	Consort	Imperial College of Science, Technology & Medicine	Ascot	Shutdown prior to conversion
April 2013	Indonesia	PT BATAN Teknologi Mo-99 production facility	BATAN	Jakarta	Full conversion

Source: GAO analysis of Global Threat Reduction Initiative data. | GAO-15-799

# Appendix VI: Comments from the Department of Energy



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



August 24, 2015

Mr. David C. Trimble  
Director  
Natural Resources and Environment  
U.S. Government Accountability Office  
Washington, DC 20548

Dear Mr. Trimble:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report titled "Nuclear Nonproliferation: DOE Made Progress to Secure Vulnerable Nuclear Materials Worldwide, but Opportunities Exist to Improve Its Efforts" GAO-15-799. NNSA concurs with GAO's recommendations, and the enclosure to this memorandum details the specific actions taken and planned to address each, as well as timelines for completion.

We would like to clarify that GAO's evaluation provides a limited view of the physical protection activities involved in the "Four Year Effort," including only the provision of security upgrades to 43 buildings in Russia under DOE's Material Protection Control and accountability (MPC&A) program and security upgrades at two sites in Mexico and South Africa under DOE's Global Threat Reduction Initiative (GTRI). GAO defined a category of "Other" to capture financial data for all other MPC&A activities, such as cooperation with Russia and international partners on MPC&A implementation, sustainability, and training. This way of characterizing financial data could be misleading as the category of "Other" encompasses a broad scope of technical efforts that are nonetheless critical components of the NNSA nuclear nonproliferation mission.

If you have any questions regarding this response, please contact Dean Childs, Director, Audit Coordination and Internal Affairs, at (301) 903-1341.

Sincerely,

Frank G. Klotz

Enclosure



Enclosure

**NATIONAL NUCLEAR SECURITY ADMINISTRATION**  
**Response to Report Recommendations**

**Nuclear Nonproliferation: DOE Made Progress to Secure  
Vulnerable Nuclear Materials Worldwide, but Opportunities Exist to  
Improve Its Efforts (GAO-15-799)**

**GAO recommends:**

**Recommendation 1:** Complete its prioritization of nuclear material at foreign locations to identify the most vulnerable materials and ensure they are given priority for removal and disposition efforts.

**Management Response: Concur**

As stated in the GAO report, the U.S. Department of Energy's National Nuclear Security Administration (DOE/NNSA) has been working to update its prioritization of nuclear material located in foreign countries. This is an ongoing process, and it involves assessing the known, civilian material holdings of highly enriched uranium (HEU) and separated plutonium at facilities around the world as well as risk factors such as site vulnerability and the country threat level. In 2014, DOE/NNSA provided a report to Congress entitled "The Four Year Effort: Progress Report and Remaining Challenges." This document outlined plans to address thousands of kilograms of high-priority nuclear material over the next several years. Currently, we are building on the information compiled for this 2014 report and expanding the scope of its assessment. The revised prioritization list will capture civilian HEU of U.S., Russian, and other origins, as well as separated plutonium in foreign countries.

DOE/NNSA expects to have a revised prioritization for removal or disposition of civilian nuclear material inventories by September 30, 2015.

**Recommendation 2:** Take further actions to visit sites containing key quantities of U.S. nuclear materials that have not been visited in at least 5 years.

**Management Response: Concur**

Consistent with current policy and as noted in the GAO report, DOE/NNSA uses a prioritization methodology to determine the schedule for conducting assessments at foreign facilities holding or expecting to receive U.S.-obligated nuclear material. The methodology considers several factors such as material type and quantity, known physical protection inadequacies (or lack of information on physical protection adequacies), projected exports of nuclear material to the country/facility, and the history of prior assessments. The U.S.

interagency has established a goal not mandated by law or regulation of conducting visits to Category I facilities every 5 years. While the U.S. Government works hard to achieve this goal, in some cases, visits have not been possible because access has been delayed or denied due to difficult political circumstances. DOE/NNSA will continue to prioritize visits in an effort to achieve the goal of visiting all Category I sites every 5 years. DOE/NNSA considers this recommendation closed based on the established schedule and prioritization.

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# Appendix VII: GAO Contact and Staff Acknowledgments

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## GAO Contact

David C. Trimble, (202) 512-3841 or [trimbled@gao.gov](mailto:trimbled@gao.gov).

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## Staff Acknowledgments

In addition to the individual named above, Dan Feehan (Assistant Director), Luke Baron, Antoinette Capaccio, Bridget Grimes, Michelle Munn, Alison O'Neill, and Rebecca Shea made key contributions to this report.

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