United States Government Accountability Office

Report to Congressional Requesters

September 2016

NUCLEAR MATERIAL

Agencies Have Sound Procedures for Managing Exchanges but Could Improve Inventory Monitoring

GAO-16-713

GAO Highlights

Highlights of GAO-16-713, a report to congressional requesters

September 2016

NUCLEAR MATERIAL

Agencies Have Sound Procedures for Managing Exchanges but Could Improve Inventory Monitoring

Why GAO Did This Study

The United States must generally account for nuclear material it has obtained under nuclear cooperation agreements with foreign partners. The agreements generally impose certain conditions, including that the material be used for peaceful purposes. Material subject to such conditions is called "obligated." The United States relies on NMMSS to track obligated material and to help demonstrate U.S. compliance with agreements. Material not subject to agreement conditions is called "unobligated." Some forms of uranium, such as LEU, are used to maintain the nuclear weapons in the U.S. stockpile, but the U.S. inventory of unobligated LEU is declining.

GAO was asked to review the practice of obligation exchanges and the reliability of certain NMMSS data. This report examines (1) the number of obligation exchanges in the United States since 2003, and the reasons for them, and (2) how DOE and NRC ensure such exchanges are accurately tracked and reported through NMMSS. GAO analyzed NMMSS data and agency documents and interviewed agency officials, DOE contractors, and NRC licensees, among other steps.

What GAO Recommends

GAO recommends that DOE and NRC (1) clarify in guidance when facilities may carry negative obligation balances and (2) develop an early-warning monitoring capability in NMMSS to alert DOE when the inventory of unobligated LEU is particularly low. DOE and NRC neither agreed nor disagreed with GAO's recommendations but stated that they have ongoing efforts that may address GAO's recommendations.

View GAO-16-713. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

In the United States, from October 1, 2003, through November 30, 2015, there were 817 exchanges of nuclear material that carried obligations to foreign partners under nuclear cooperation agreements. These exchanges allowed the obligated nuclear material to be transferred between U.S. facilities without physically moving it. For example, if a facility had a certain amount of obligated nuclear material and another facility had at least the same amount and type of unobligated material (which is not subject to the same conditions as obligated material), the facilities could exchange the obligations on their material so that each facility had a portion of both types of material without physically moving it.

- **Numbers of exchanges.** Of the 817 exchanges, 802 were conducted by Nuclear Regulatory Commission (NRC)-licensed facilities—private companies and other entities involved in commercially producing nuclear energy. Of the remaining exchanges, 14 were conducted by contractors that run Department of Energy (DOE) laboratories and weapons-production sites, and 1 by an NRC licensee that does both commercial and DOE work.
- **Reasons for exchanges.** NRC licensees said they conducted exchanges primarily to meet their utility customer demand, as well as to avoid the high costs and safety risks associated with physically transporting nuclear material. DOE contractors said they conducted exchanges primarily to avoid physically moving nuclear material stored at a specific site.

DOE and NRC have procedures to ensure accurate tracking and reporting of data on obligation exchanges through the Nuclear Materials Management and Safeguards System (NMMSS). GAO tested elements of these procedures and generally found them to be reliable. But, GAO identified two issues that may impact the agencies' ability to effectively monitor nuclear material inventories.

- First, some facilities have carried negative obligation balances for extended periods. A negative obligation balance occurs when a facility conducts an exchange without having enough of a given material in its physical inventory to cover the exchange. In certain circumstances, negative balances may place the United States at risk of noncompliance with nuclear agreements. Negative balances have occurred because DOE and NRC have not addressed this issue in documented guidance on when facilities may carry such balances, which is inconsistent with federal internal control standards.
- Second, while unobligated low-enriched uranium (LEU) could be used to correct any future negative obligation balances, the U.S. inventory of it is declining and NMMSS does not have an early-warning monitoring capability to alert DOE when the inventory is particularly low. Federal internal control standards state that agencies should establish activities to monitor internal control systems and evaluate the results, but DOE officials said that the LEU inventory is currently sufficient and no early warning capability is needed. Without developing such a capability in NMMSS, DOE officials cannot know when the inventory of unobligated LEU becomes so low that supplies may not be available to correct negative obligation balances, thereby putting the United States at risk of not complying with its nuclear agreements.

Contents

Abbreviations

DOE	Department of Energy
EURATOM	European Atomic Energy Community
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
LEU	low-enriched uranium
NMMSS	Nuclear Materials Management and Safeguards System
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
TVA	Tennessee Valley Authority
USEC	USEC Inc.

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

September 23, 2016

The Honorable Edward J. Markey
Ranking Member
Committee on Environment and Public Works
Subcommittee on Superfund, Waste Management,
and Regulatory Oversight
United States Senate

The Honorable Michael C. Burgess
House of Representatives

The United States must generally account for nuclear material—such as uranium and plutonium—that has been obtained under agreements for peaceful nuclear cooperation between the United States and its foreign partners.[1] Under these agreements, the U.S. government tracks the amounts, locations, and uses of imported nuclear material and periodically reports this information to its foreign partners. The agreements generally impose certain terms and conditions on transfers of nuclear material and equipment, including adequate physical protection, application of safeguards, and peaceful use.[2] Material and equipment subject to such conditions are referred to as "obligated," or carrying a foreign obligation. Material and equipment not subject to such conditions are referred to as "unobligated," or not carrying a foreign obligation. The

[1]Under Section 123 of the Atomic Energy Act, the United States had 22 agreements for peaceful nuclear cooperation in force as of June 2016 with foreign countries, the European Atomic Energy Community (EURATOM), the International Atomic Energy Agency (IAEA), and Taiwan. EURATOM is composed of the 28 countries of the European Union. The IAEA is an independent international organization that is affiliated with the United Nations—it 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. The parties to the Taiwan agreement are the American Institute in Taiwan and the Taipei Economic and Cultural Representative Office in the United States. In this report, we refer to the countries, EURATOM, IAEA, and Taiwan as partners.

[2]Peaceful use provisions generally state that material, equipment, and components subject to the agreements will not be used for any nuclear explosive device, for research on or development of any nuclear explosive device, or for any military purposes.

agreements' peaceful use provisions mean that foreign-obligated nuclear material in the United States cannot be used for military purposes. To enable it to demonstrate to its foreign partners that foreign-obligated nuclear material is used in compliance with peaceful use provisions, the U.S. government relies on the Nuclear Materials and Management Safeguards System (NMMSS) as its system to track such material and report material balances to foreign partners.

NMMSS is managed by the Department of Energy's (DOE) National Nuclear Security Administration (NNSA), a separately organized agency within DOE that is responsible for the management and security of the nation's nuclear weapons, nonproliferation, and naval reactors programs.[3] Jointly funded by DOE and the Nuclear Regulatory Commission (NRC), the nuclear regulatory body of the United States,[4] NMMSS is the U.S. government's official database for tracking nuclear material inventories, material balances, and transactions in the United States.[5] The United States relies on NMMSS to track nuclear material as it is imported to, exported from, or moved within the United States and to process about 1 million transaction records each year. Approximately 420 commercial nuclear and government entities submit data to NMMSS on 17 different nuclear materials, including those that can be used in industrial and medical applications as well as the types of uranium and plutonium that can be used directly to manufacture nuclear explosives. These entities include facilities licensed by NRC, which are private companies involved in the commercial production of and research on nuclear energy, as well

[3]NMMSS is managed by NNSA's Office of Nuclear Materials Integration and is operated by a DOE contractor at department headquarters in Germantown, MD.

[4]According to DOE officials, DOE contributes about 56 percent of the annual $4 million operating costs, and NRC contributes the remaining 44 percent.

[5]According to DOE and NRC documents, "inventory" refers to a physical determination of the quantity of nuclear material at a given facility at a given point in time. "Material balance" refers to the comparison of beginning inventory plus receipts of nuclear material with ending inventory plus shipments of nuclear material plus measured discards for a specific time interval. "Transaction" refers to any recorded change affecting a facility's nuclear material inventory, such as the physical movement of nuclear material or adjustment of obligation balances.

as academic institutions.[6] DOE laboratories and weapons production sites also submit data to NMMSS; these laboratories and sites are responsible for military uses of nuclear material and are owned by the U.S. government but managed and operated by contractors.

One type of transaction conducted by both NRC licensees and DOE contractors, and recorded in NMMSS, is known as an "obligation exchange." An obligation exchange involves the transfer between entities of the obligations on nuclear material without physical movement of the material.[7] For example, Facility A may have a certain amount of material physically located on its site, all of which is obligated. Facility B may have an equal amount of material physically located on its site, all of which is unobligated. In an obligation exchange between the two facilities, rather than Facility A physically transferring a portion of its obligated material to Facility B in exchange for the same amount of unobligated material, the two facilities can exchange the obligations on the material, so that each facility now has a portion of obligated and a portion of unobligated material. The total amounts of nuclear material at each facility do not change, and no material is physically moved, but the conditions on the use of the material have changed.

According to DOE documents, the United States has a vital national security need for unobligated low-enriched uranium (LEU), which is used in the production of tritium—a key isotope used in nuclear weapons.[8] DOE reported in October 2015 that obtaining tritium is its "most pressing

[6]These facilities may be licensed by NRC or by states. The Atomic Energy Act authorizes NRC to enter into agreements with states (called agreement states) so that the states assume, and the NRC relinquishes, regulatory authority over specified radioactive materials. 42 U.S.C. § 2021(b) (2015).

[7]Obligation exchanges may also occur within facilities, but those are not reported to NNMMS and are outside the scope of our work. Because nuclear materials, such as uranium and plutonium, are considered by the industry to be fungible—that is, being of a nature that is easily exchangeable—the obligation exchange is made within nuclear material inventory records, and no physical material is actually moved. Per DOE and NRC guidance, facilities are encouraged to conduct obligation exchanges for like types and quantities of nuclear material.

[8]Isotopes are varieties of a given chemical element with the same number of protons but different numbers of neutrons. Tritium is a radioactive isotope of hydrogen.

defense mission need."[9] As long as the United States relies on nuclear weapons, DOE requires a continuous supply of LEU to produce tritium. However, according to DOE officials, the domestic supply of unobligated LEU is declining, in part because the United States lost its sole supplier of unobligated LEU in May 2013. At that time, a former government-owned corporation—created in 1992 as the United States Enrichment Corporation and then privatized in 1998—ceased enriching uranium at the Paducah Gaseous Diffusion Plant.[10] As of 2015, the majority of LEU in the United States carried foreign obligations, and DOE officials stated that this material could not be used for tritium production.[11] According to DOE officials, only unobligated LEU can be used for tritium production.

[9]DOE, *Tritium and Enriched Uranium Management Plan Through 2060*, Report to Congress (Washington D.C.; October 2015).

[10]In 1992, the United States Enrichment Corporation was established as a government corporation to, among other things, take over operations of DOE's enrichment facilities, which included the Paducah Gaseous Diffusion Plant in Paducah, Kentucky. In 1998, the United States Enrichment Corporation was privatized under the USEC Privatization Act and became a subsidiary of the newly created USEC Inc. From 1998 until 2013, DOE relied exclusively on USEC to enrich the LEU needed to produce tritium. However, USEC ceased enrichment operations at the Portsmouth, Ohio, and Paducah plants in 2001 and 2013, respectively, citing high production costs. In September 2014, following Chapter 11 bankruptcy proceedings, USEC Inc. changed its name to Centrus Energy Corp. For the purposes of this report, we will refer to the company as United States Enrichment Corporation when discussing events prior to privatization, USEC Inc. (USEC) when discussing events between privatization and September 2014, and we will refer to the company as Centrus Energy Corp. when discussing events after September 2014. We have previously reported on financial and other transactions involving DOE and USEC and their relationship since the company was privatized. See GAO, *Department of Energy: Enhanced Transparency Could Clarify Costs, Market Impact, Risk, and Legal Authority to Conduct Future Uranium Transactions*, GAO-14-291 (Washington, D.C.: May 9, 2014) and GAO *Department of Energy: Transactions Involving USEC Inc. Since 1998*, GAO-15-730 (Washington, D.C.: Sept. 10, 2015).

[11]The only enrichment facility in the United States is the URENCO USA facility, which is located in New Mexico. This facility is owned and operated by Louisiana Energy Services, a subsidiary of URENCO, which is a consortium of companies owned or controlled by the British and Dutch governments and by two German utilities. The LEU produced by URENCO is enriched using foreign technology and is foreign obligated. There are no United States-owned enrichment facilities or foreign-owned enrichment facilities that use U.S. technology operating outside of the United States.

This position is based on both law and policy considerations, and we examined this issue in a 2014 report.[12]

The U.S. government relies on NMMSS as its accounting system for tracking and reporting of foreign obligated material.[13] Specifically, NMMSS data is used to produce annual obligation inventory reports for the United States to provide to its foreign partners. The annual obligation inventory reports enable the United States to demonstrate compliance with its nuclear cooperation agreements and provide assurance to foreign partners that their nuclear material is being used only for peaceful purposes, according to NNSA officials.

Questions have been raised about the practice of obligation exchanges, including about the reliability and integrity of certain NMMSS data, which are used to demonstrate compliance with nuclear cooperation agreements. You asked us to review the practice of obligation exchanges and the reliability of certain NMMSS data. This report examines (1) the number of exchanges involving foreign obligated nuclear material that have taken place in the United States since 2003 and the reasons for the exchanges and (2) how DOE and NRC ensure accurate tracking and reporting of obligation exchanges through NMMSS.

For both objectives, we reviewed the text of U.S. agreements for peaceful nuclear cooperation (nuclear cooperation agreements). We also reviewed portions of the administrative arrangements for implementing these agreements that relate to obligation accounting and reporting for four key U.S. nuclear trading partners: Australia, Canada, the European Atomic Energy Community (EURATOM), and Japan.[14] To determine how many exchanges involving foreign obligated nuclear material have taken place in the United States since 2003, as well as the reasons for the

[12]GAO, *Department of Energy: Interagency Review Needed to Update U.S. Position on Enriched Uranium That Can Be Used for Tritium Production*, GAO-15-123, (Washington, D.C.: Oct. 14, 2014).

[13]DOE and NRC are the key agencies that use NMMSS data for domestic safeguards, tracking nuclear materials, satisfying international commitments, and supporting licensing and inspection activities, among other purposes.

[14]According to DOE officials, nuclear material entering the United States is likely to have an obligation from one or more of these partners, which are significant producers of nuclear material.

exchanges, we examined NMMSS data on obligation exchanges conducted by DOE sites and NRC-licensed facilities from October 1, 2003, through November 30, 2015.[15] We identified eight NRC-licensed facilities that conducted obligation exchanges during this period and interviewed representatives from each of those facilities. We also identified the two DOE sites that conducted obligation exchanges during this period and interviewed officials from those sites.

To determine how DOE and NRC ensure accurate tracking and reporting of obligation exchanges through NMMSS, we took the following steps:

- We analyzed DOE and NRC documents that describe the requirements for obligation exchanges, including those on data entry and reporting procedures.
- We obtained and reviewed NMMSS data on obligation exchanges, including shipment and receipt data of obligated material for each DOE and NRC facility that had conducted an obligation exchange during this period. We compared these data with NMMSS inventory records and checked for differences.
- We visited two U.S. facilities holding foreign obligated material—a uranium enrichment facility and a fuel fabrication facility—and interviewed representatives from these facilities on their nuclear material accounting procedures and obligation exchange activity.
- We interviewed NNSA and NRC officials, and current and former NMMSS officials, to identify any limitations in NMMSS's data.
- We interviewed DOE and contractor representatives from DOE sites to learn about their obligation exchange activity as well as representatives from NRC-licensed facilities from different stages of the nuclear fuel cycle, to learn about the commercial issues that drive obligation exchanges. In addition, we interviewed representatives from organizations that either promote or consult on the nuclear industry to get a general understanding of obligation exchanges.
- We interviewed officials from the Tennessee Valley Authority (TVA), a government corporation and the nation's largest public power

[15]We selected October 1, 2003, as the starting point because this was the date obligation accounting began in NMMSS. We reviewed data through November 30, 2015, as it was the date of the most recent data available at the time of our review.

company, to learn about its involvement in obligation exchanges and its steps to preserve unobligated LEU.

We assessed the reliability of NMMSS obligation exchange data by (1) performing electronic testing of required data elements; (2) reviewing existing information about the data and the system that produced them; and (3) interviewing agency officials knowledgeable about the data. We found the data to be sufficiently reliable for the purposes of our review.

We conducted this performance audit from June 2015 to September 2016 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

This section describes the legal framework for obligation accounting, the uranium market and how obligations on uranium may be added at various stages of the nuclear fuel cycle, the mechanics of obligation exchanges, and the national security need for unobligated LEU.

Legal Framework for Obligation Accounting

The United States has negotiated nuclear cooperation agreements under section 123 of the Atomic Energy Act of 1954, as amended, with nuclear trading partners worldwide. These agreements establish obligations governing how nuclear material and equipment subject to the agreements are to be used. The United States had 22 nuclear cooperation agreements in force as of June 2016.[16]

[16]As of June 2016, the United States had 22 nuclear cooperation agreements in force with the following foreign partners: Argentina, Australia, Brazil, Canada, China, Egypt, EURATOM, IAEA, India, Indonesia, Japan, Kazakhstan, Morocco, Russia, South Africa, South Korea, Switzerland, Taiwan, Turkey, Ukraine, the United Arab Emirates, and Vietnam. EURATOM consists of 28 member states: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Once a nuclear cooperation agreement has been negotiated, U.S. government officials may negotiate an administrative arrangement that provides procedures for implementing the agreement, including details about accounting for foreign obligated material. Administrative arrangements with foreign partners may require DOE to produce annual reports on inventories of obligated material. For example, under the administrative arrangements for Australia, Canada, and EURATOM, the reports are to be conducted at the country level, not by facility. According to DOE documents, this is generally the case with its foreign partners. The annual obligation inventory reports summarize the import and export of foreign obligated material into and out of the United States in a given year. NMMSS produces summary information for these reports, which contain aggregated data for foreign obligation balances at all U.S. facilities by calendar year.[17] After NMMSS generates data for the annual obligation inventory reports, NNSA provides these reports to U.S. foreign partners. These foreign partners use the reports to periodically reconcile their accounting records with those of the United States.

Other regulations, orders, guidance and an international agreement govern the accounting and reporting of nuclear material as well. For example, a DOE order and NRC regulations establish requirements for nuclear material control and accounting and the reporting of nuclear materials to NMMSS. The DOE order provides direction on the procedures that DOE contractors are to use in submitting data on certain quantities of 17 DOE-owned reportable nuclear materials.[18] NRC regulations require NRC licensees to submit data to NMMSS on certain

[17]Most annual obligation inventory reports do not contain data on the number of obligation exchanges involving foreign obligated material. For example, a report may specify how much Canada-obligated material was held in the United States but not how many obligation exchanges involving Canada-obligated material were conducted in the United States.

[18]The 17 reportable materials are: americium-241, americium-243, californium, curium, depleted uranium, deuterium, enriched lithium, enriched uranium, natural uranium, neptunium-237, plutonium-238, plutonium-239-241, plutonium-242, thorium, tritium, uranium-233, and uranium in cascade—which refers to uranium that is being processed through uranium enrichment equipment. While NMMSS tracks 17 nuclear materials, it tracks foreign obligations for only 6: depleted uranium, enriched uranium, natural uranium, plutonium, thorium, and uranium-233.

quantities of some of these nuclear materials.[19] In addition, the United States has an agreement with the International Atomic Energy Agency (IAEA) on the safeguard of nuclear material, which requires the United States to maintain a system of accounting and control over certain nuclear material. Through the application of safeguards, IAEA seeks to verify that nuclear material subject to safeguards is not diverted to nuclear weapons or other proscribed purposes.

Uranium Market and How Obligations on Uranium May Be Added at Various Stages of the Nuclear Fuel Cycle

Uranium is a commodity that is necessary for commercial nuclear power. The market is global, and the vast majority of the uranium used to fuel U.S. commercial nuclear reactors is mined abroad. According to a 2016 U.S. Energy Information Administration,[20] report, in 2015, only 6 percent of the 57 million pounds of uranium delivered to fuel U.S. nuclear reactors was of U.S. origin.[21] Of the remaining 94 percent, 47 percent originated in Australia or Canada; 37 percent originated in Kazakhstan, Russia, or Uzbekistan; and the remaining 10 percent originated in Bulgaria, the Czech Republic, Malawi, Namibia, Niger, or South Africa.[22]

After being mined, uranium undergoes a number of additional processing steps to become nuclear fuel for commercial reactors. These steps make up the nuclear fuel cycle. Obligations on nuclear material may be added at various stages in the cycle (see fig. 1). For example, if uranium is mined and milled in Australia and is then shipped to Canada, it may carry an Australian obligation. If the uranium goes through conversion at a plant

[19]NRC licensees are directed to report certain quantities of eight nuclear materials to NMMSS: depleted uranium, enriched uranium, natural uranium, plutonium, plutonium-238, thorium, uranium-233, and uranium in cascade.

[20]The Energy Information Administration is an agency within DOE that collects, analyzes, and disseminates independent and impartial statistical and analytical energy information.

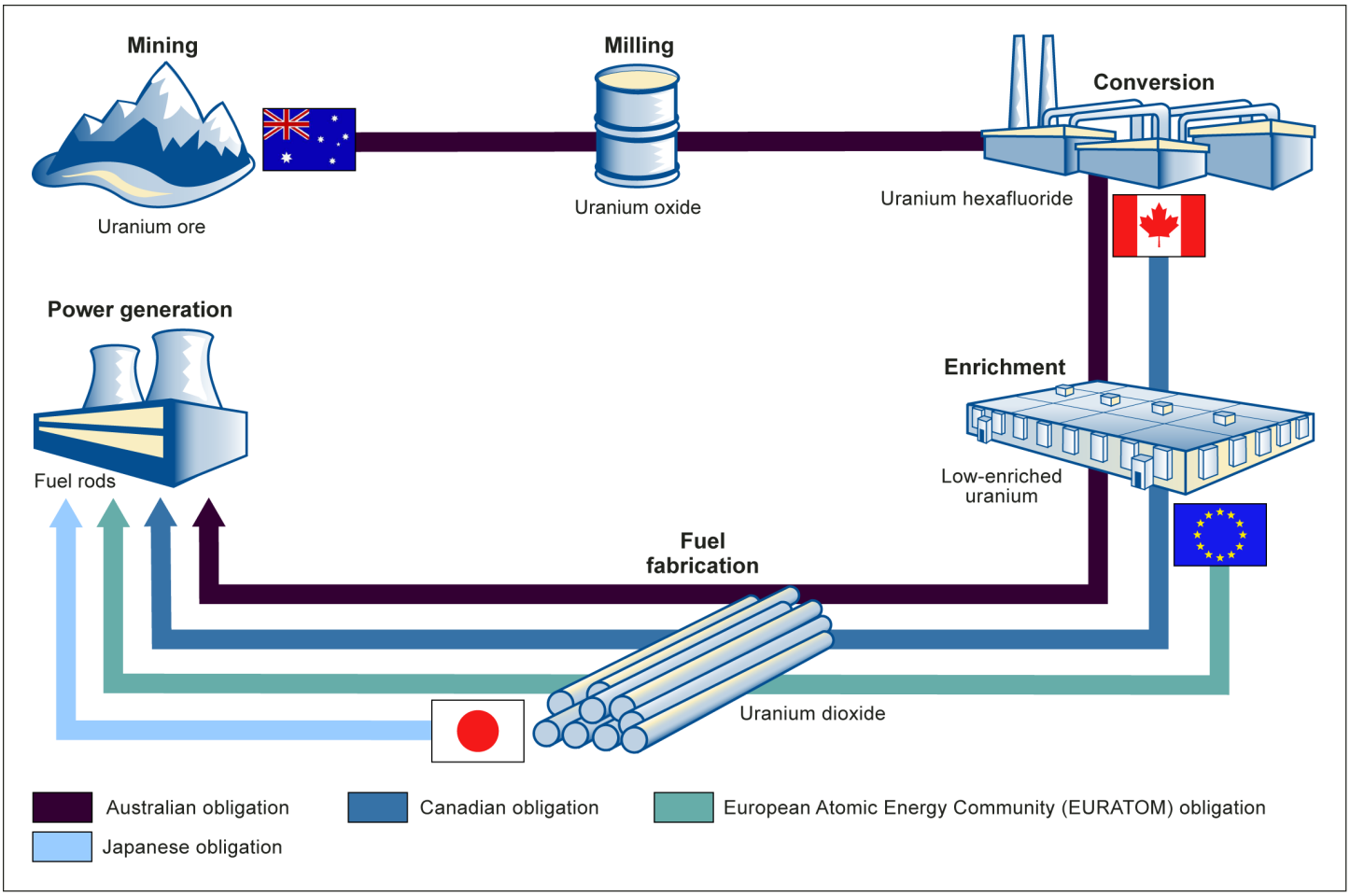
[21]U.S. Energy Information Administration, *2015 Uranium Marketing Annual Report* (Washington, D.C.: May 2016).

[22]Not all of the natural uranium entering the United States is obligated. Some uranium-producing countries, such as Uzbekistan and Namibia, do not have nuclear cooperation agreements with the United States. As a result, uranium entering the United States from these countries is unobligated. In addition, according to NRC officials, countries with nuclear cooperation agreements can send material to the United States outside the requirements of the nuclear cooperation agreement, thereby providing unobligated material. Countries that have done so include Kazakhstan and Russia, according to DOE officials.

using Canadian technology and is then shipped to Europe, it may carry a Canadian obligation. If the uranium is enriched at a plant using European technology and is then shipped to Japan, it may carry an obligation from EURATOM. Finally, if the uranium undergoes fuel fabrication at a plant using Japanese technology before export to a final user in the United States, it may carry a Japanese obligation. By the end of the process, the uranium may carry obligations to Australia, Canada, EURATOM, and Japan. Figure 1 illustrates how obligations may be added to uranium at various stages of the nuclear fuel cycle.[23] Such obligations are tracked in NMMSS while the material remains in the United States.

[23]Examples provided are illustrative only. We did not analyze the terms of any nuclear cooperation agreements entered into by Australia, Canada, EURATOM, or Japan other than those entered into with the United States.

Figure 1: Example of How Obligations on Uranium May Be Added at Various Stages of the Nuclear Fuel Cycle



Sources: GAO analysis of International Atomic Energy Agency, Nuclear Regulatory Commission, Congressional Research Service, Department of Energy, and Tennessee Valley Authority documents. GAO-16-713

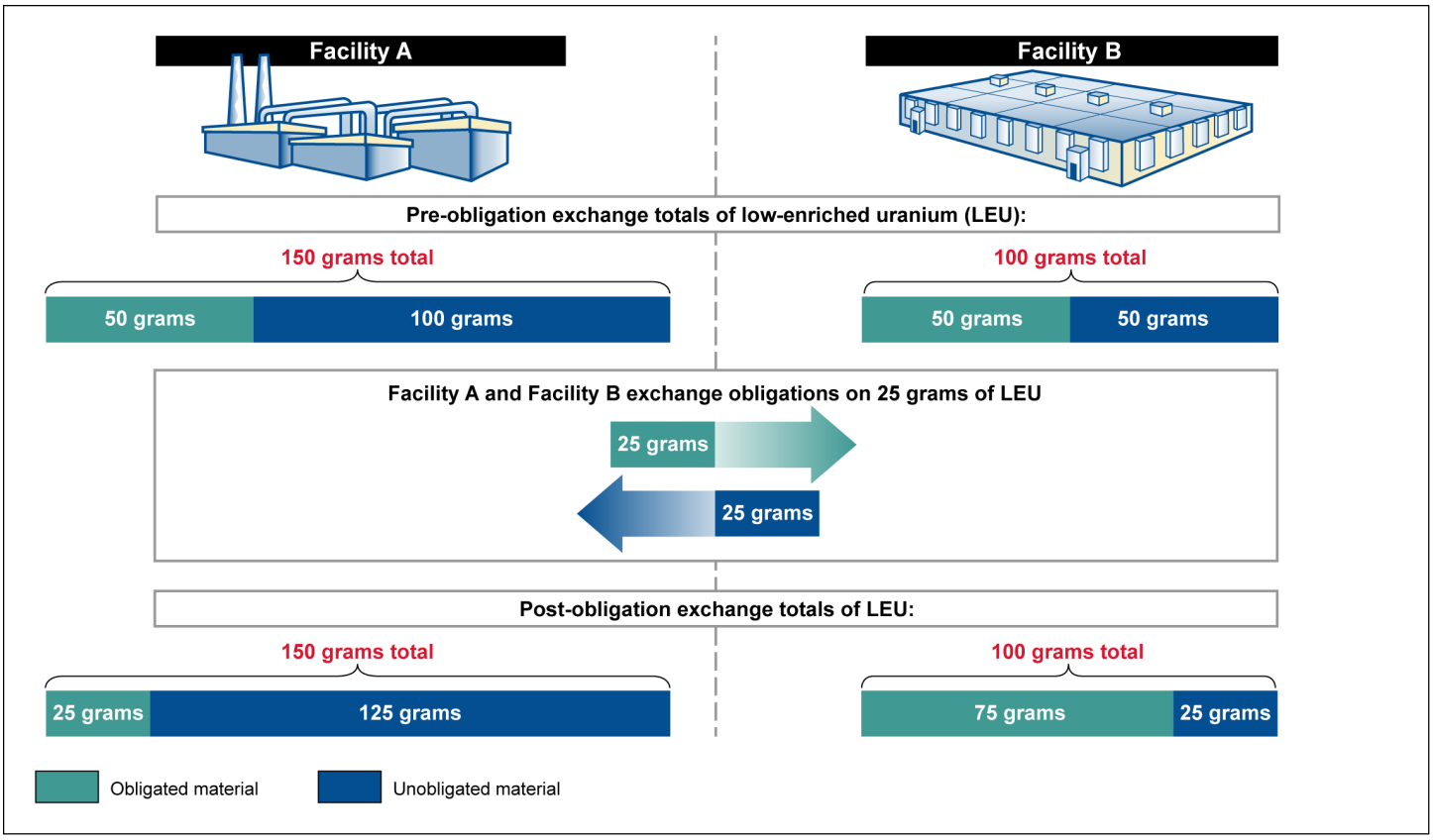
Note: EURATOM is composed of the 28 countries of the European Union.

Mechanics of Obligation Exchanges

To conduct an obligation exchange and record the transaction in NMMSS, both the facility "shipping" the obligation and the facility "receiving" the obligation must submit a DOE/NRC Form 741, "Nuclear

Material Transaction Report," to NMMSS.[24] The shipper's transaction report and the receiver's transaction report should contain the same data. Following an obligation exchange, each facility will have the same total amount of a given material type, such as LEU, as it had before the exchange, but it will have different proportions of obligated and unobligated material (see fig. 2).

Figure 2: Example of an Obligation Exchange Involving Nuclear Material



Source: GAO analysis of Nuclear Materials Management and Safeguard System information. | GAO-16-713

[24]Specifically, Nuclear Material Transaction Reports, which DOE and NRC both refer to by the number of the old paper form, 741, must be submitted for inventory adjustments of 1 kilogram or more of certain source material, such as uranium, or 1 gram or more of certain special nuclear material, such as enriched uranium or plutonium. Different requirements may apply to different materials.

National Security Need for Unobligated LEU

Tritium is a key radioactive isotope used to enhance the power of nuclear weapons in the U.S. stockpile.[25] Tritium is produced in nuclear reactors, and NNSA supports a program that produces tritium from LEU to help meet stockpile demands. NNSA's tritium program requires that only unobligated LEU be used in reactors to produce tritium. The reactors that are under agreement to produce tritium for DOE belong to TVA, a government corporation, and, according to DOE, LEU fuel loaded into TVA reactors for tritium production must consist entirely of LEU that is unobligated.[26]

It is DOE's responsibility to ensure that TVA is supplied with unobligated fuel to support tritium production. DOE maintains an inventory of unobligated LEU. However, the United States lost its sole supplier of unobligated LEU when USEC ceased uranium enrichment operations in 2013.[27] In 2014, NNSA projected that unobligated LEU fuel for tritium production would last through 2027.[28] NNSA has since identified several actions that could extend that projected date from 2038 to 2041.[29] These actions include "downblending" highly enriched uranium (HEU)[30] from dismantled weapons to produce unobligated LEU, as well as conducting

[25]Tritium has a relatively short half-life of 12 years (it decays at a rate of about 5.5 percent per year), and it must be periodically replenished in existing weapons.

[26]To produce tritium, stainless steel rods containing lithium aluminate and zirconium are irradiated in TVA's Watts Bar 1 commercial nuclear power reactor.

[27]The company had been developing next-generation uranium enrichment technology, called the American Centrifuge. The future of the company's planned enrichment facility—the only enrichment facility that would have been able to produce unobligated LEU—is uncertain. DOE announced that it would not fund the company's demonstration of American Centrifuge technology at the American Centrifuge Plant in Piketon, Ohio, after September 30, 2015. Since then, the company has been demobilizing the demonstration project and reducing its workforce at the plant.

[28]DOE, *National Nuclear Security Administration, Tritium Readiness Subprogram Tritium Production Fuel Supply Plan*, May 2014.

[29]DOE, *Tritium and Enriched Uranium Management Plan Through 2060*.

[30]HEU is used both in nuclear weapons and in the reactors that power the U.S. Navy's aircraft carriers and submarines. The United States has not had a domestic capability to produce HEU since 1992 and instead meets national security needs using an inventory of HEU that was enriched prior to 1992. According to DOE, based on mission requirements, DOE's current HEU allocations are sufficient to meet naval propulsion national security demands through 2064.

obligation exchanges to preserve unobligated LEU.[31] According to DOE, to meet defense mission requirements in the future, the United States will eventually need to reestablish the capability to produce unobligated LEU. In the meantime, NNSA and TVA have been working together to identify actions to preserve DOE's remaining quantities of unobligated LEU.[32]

Over 800 Obligation Exchanges Have Taken Place Since October 2003, and Most Were Conducted for Commercial Reasons

From October 1, 2003, through November 30, 2015, 817 obligation exchanges took place in the United States, and most were conducted to meet commercial customer demand. The majority (98 percent) of these exchanges involved NRC-licensed commercial facilities; the rest were conducted by DOE contractors. NRC licensees told us they generally conducted exchanges to meet customer demand for material with obligations from certain countries and to avoid the need to physically transport uranium. DOE contractors told us they conducted a number of obligation exchanges primarily to accommodate the closure of the vault where the material was being stored.

[31]HEU can be "downblended" by mixing it with depleted, natural, or LEU to produce a new product that has a lower concentration of uranium-235. According to DOE officials, NNSA is currently downblending a fixed amount of HEU that has been identified as excess to nuclear weapon requirements. The balance of unobligated HEU and LEU changes based on the rate of downblending and consumption by naval propulsion reactors and tritium production reactors. According to DOE officials, NNSA continually evaluates programmatic requirements, budgets, and material processing capabilities to determine if additional HEU should be declared excess to weapon requirements and made available for other priorities such as production of tritium and manufacture of naval fuel. The specific allocations of unobligated materials made available to support these national security needs would be based on an evaluation of the quality of the material; the costs associated with downblending a national asset that the U.S. government cannot currently produce; and the impacts to the schedule for, and cost of, developing a new enrichment facility.

[32]These actions are described in TVA's Obligation Preservation Action Plan, which describes actions that are to be taken or considered related to obligation management in support of NNSA's Tritium Program.

Exchanges Typically Involved Commercial Nuclear Facilities, and Numbers of Exchanges Have Decreased in Recent Years

According to NMMSS data, there were 817 exchanges of foreign obligated nuclear material in the United States from October 1, 2003, through November 30, 2015.[33] The majority of these obligation exchanges were between commercial nuclear facilities and involved particular material types and certain types of obligations. Specifics on the exchanges follow.

- Of the 817 obligation exchanges, 802 (98 percent) were conducted by NRC-licensed commercial nuclear facilities;[34] 14 were conducted by DOE contractors; and 1 was conducted by an NRC licensee that conducts work both for commercial purposes and for DOE.
- The majority (99 percent) of the obligations exchanged involved LEU or natural uranium, and the remaining 1 percent consisted of two obligation exchanges involving plutonium and two involving depleted uranium.
- The majority (99 percent) of obligation exchanges involved facilities exchanging obligated for unobligated material.[35] The remaining 1 percent involved facilities exchanging obligated material for obligated material.

[33]Apart from these 817 obligation exchanges, which were tracked in NMMSS, we found that there were additional obligation exchanges conducted by NRC licensees and DOE contractors outside of NMMSS. NMMSS records only cover "inter-facility" obligation exchanges—that is, the transfer of obligations between different facilities—which requires the submission of a DOE/NRC Form 741, "Nuclear Material Transaction Report." However, some NRC licensees reported that they conduct "intra-facility" obligation exchanges, in which obligations are transferred within the same facility but across different customer accounts. Because the "intra-facility" obligation exchanges are not reported to NMMSS, we were unable to determine the number or frequency of these exchanges. We were told by one NRC licensee that these exchanges happen frequently.

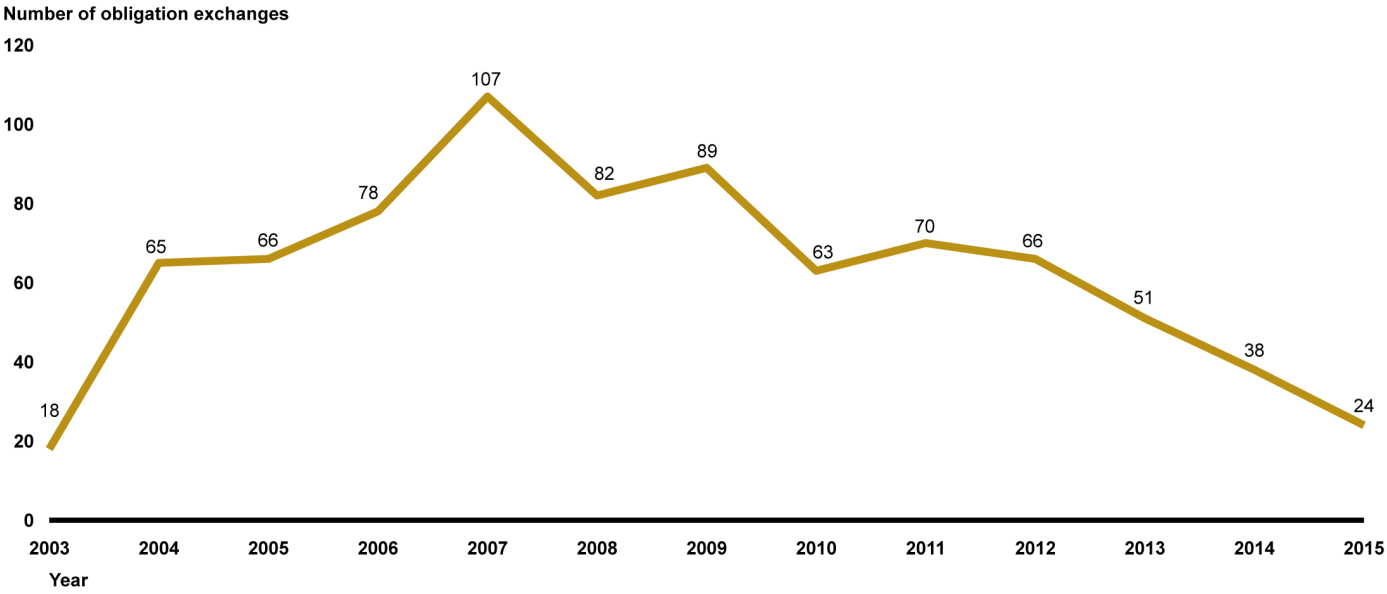
[34]For the purposes of our analysis, the Paducah and Portsmouth gaseous diffusion plants, which are shuttered uranium enrichment facilities, were categorized as NRC-licensed facilities. When the Energy Policy Act of 1992 transferred management and operation of the gaseous diffusion plants from DOE to the United States Enrichment Corporation, it also required NRC to promulgate standards for the plants and to assess the plants through a certification of compliance in lieu of licensing. The plants were held to the same requirements for material control and accounting of special nuclear material, including reporting to NMMSS, as licensees.

[35]According to NMMSS officials, while it is possible for facilities to exchange obligated material for like obligated material, there have only been two such exchanges.

- The majority (92 percent) of the obligations exchanged involved obligations from either Australia or Canada. Five percent were obligations from Argentina, Brazil, Chile, China, EURATOM, or Japan, and 3 percent involved material with layered obligations—that is, obligations to multiple countries.

The number of obligation exchanges peaked in 2007 with 107 exchanges and has generally declined since then, with steady declines since 2011. Figure 3 shows the number of obligation exchanges conducted in the United States from October 1, 2003, through November 30, 2015.

Figure 3: Number of Obligation Exchanges from October 1, 2003, through November 30, 2015



Source: GAO analysis of Department of Energy and Nuclear Regulatory Commission data. | GAO-16-713

According to officials from Centrus Energy Corp. (formerly USEC), the company that conducted the most obligation exchanges from 2003 to 2015—the peak in 2007 resulted from increased demand that year for LEU. The officials noted that the demand for LEU fluctuates and can be cyclical, as most nuclear power plants operate on an 18-month cycle and must be shut down at regular intervals to replace spent fuel rods with new ones. The officials attributed the decline in obligation exchanges to decreased demand for LEU and to the May 2013 closure of the Paducah

Gaseous Diffusion Plant, which meant that less unobligated LEU was available.

Most Exchanges Were Conducted to Meet Commercial Customer Demand for Uranium with Specific Obligations and to Avoid Physically Transporting Material

According to NRC licensees, exchanges were generally conducted to meet commercial customer demand for material with obligations from certain countries and to avoid the need to physically transport uranium. In contrast, DOE contractors told us they conducted a number of obligation exchanges primarily to accommodate the closure of the vault where the material was being stored.

Obligation Exchanges Conducted by NRC Licensees

According to NRC licensees, obligation exchanges were conducted primarily to meet their customers' demand for uranium with specific obligations. These customers were utility companies that may have had contracts that specified the delivery schedule and obligation requirements for LEU years in advance of delivery of material. NRC licensees told us that sometimes, as a result of these contracts, facilities needed to deliver uranium with specific obligations before they had physically obtained uranium with the required obligations, so they conducted obligation exchanges with other facilities to obtain and provide the material on the required schedule. Customers wanted either unobligated LEU or LEU with obligations from certain countries to help simplify their nuclear material accounting. For example, representatives from one facility stated that their customers prefer to obtain unobligated LEU to avoid having to maintain separate inventories of obligated and unobligated material, as each obligation type needs to be tracked separately in NMMSS. By having unobligated material, or limiting the number of different obligations, facilities were able to minimize the number of tracking steps.

According to some NRC licensees, conducting obligation exchanges also allowed them to obtain the obligations their customers wanted without physically transporting uranium from another NRC-licensed facility. They stated that obligation exchanges allowed them to avoid the high transportation costs and safety risks associated with physically shipping nuclear material. Overall, NRC licensees told us that obligation exchanges are a customary and normal business practice in the nuclear fuel industry. Representatives from one NRC licensee told us that the facility "could not operate" without conducting obligation exchanges and that it is an essential industry-wide practice.

In addition, we found that certain NRC licensees conducted obligation exchanges for national security purposes—that is, to obtain unobligated LEU for tritium production. Specifically, of the 802 obligation exchanges conducted by NRC licensees, 3 were conducted by licensees that supplied nuclear fuel to TVA, which produces tritium for NNSA. In 2014 and 2015, on behalf of TVA, three NRC-licensed facilities each conducted an obligation exchange to preserve unobligated LEU for tritium production at TVA's Watts Bar 1 commercial nuclear power reactor. According to DOE officials, such obligation exchanges help extend the date when the United States will run out of unobligated LEU for tritium production. According to DOE officials, these obligation exchanges are necessary because the United States no longer has a domestic source of unobligated LEU for tritium production. TVA and DOE officials stated that additional exchanges for national security are anticipated in the future—perhaps one or two each year.[36]

Obligation Exchanges Conducted by DOE Contractors

DOE contractors and on-site agency officials told us they conducted 14 obligation exchanges primarily to accommodate the closure of the vault where the material was being stored. Specifically, 13 of the 14 obligation exchanges were conducted to transfer obligations to accommodate DOE closure of a vault in a building at the Y-12 National Security Complex, which was scheduled for modernization. As part of the effort to empty the vault, contractors transferred the obligations on this material to other facilities, allowing them to relocate the now unobligated material from the vault. The other exchange was conducted to transfer obligated plutonium to a facility under IAEA safeguards at the Savannah River Site, according to DOE contractors.

[36]DOE is required to submit a biennial plan to Congress that includes a description of "swap and barter agreements" needed to meet national security requirements. National Defense Authorization Act for Fiscal Year 2016, Pub. L. No. 114-92, § 3131 129 Stat. 726, 1202 (2015). "Swap" is another term for obligation exchange. Since NMMSS is not designed to track the purpose of an obligation exchange, according to NNSA and TVA officials, NNSA will work with TVA to ensure that information pertaining to the number of obligation exchanges for national security is included either in future TVA Obligation Preservation Action Plans or NNSA planning documents.

DOE and NRC Have Procedures for Accurate Tracking and Reporting of Obligation Exchanges, but Conditions Exist That May Affect Agencies' Abilities to Use NMMSS to Demonstrate Compliance With Nuclear Cooperation Agreements

DOE and NRC have three procedures designed to ensure accurate tracking and reporting of transaction data in NMMSS, including data on obligation exchanges. However, conditions exist that may affect agencies' abilities to use NMMSS to demonstrate compliance with nuclear cooperation agreements in the future and monitor unobligated inventories effectively.

DOE and NRC Have Procedures for Accurate Tracking and Reporting of Obligation Exchanges

DOE and NRC have three procedures designed to ensure the accurate tracking and reporting of transaction data in NMMSS.[37] These procedures apply to all transaction data in NMMSS, including data on obligation exchanges. The procedures are validation, reconciliation, and export records comparison.

[37]DOE also promotes the accurate tracking and reporting of transaction data by providing training and guidance to DOE contractors and NRC licensees on how to use NMMSS. In terms of training, DOE and NRC offer an annual NMMSS users' conference that includes informational presentations on such topics as obligation accounting and obligation exchanges. Also, NMMSS program officials provide multiday trainings several times a year, including separate trainings for DOE contractors and NRC licensees that are tailored to meet their specific needs. In terms of guidance, there are two sets of guidance for NMMSS users. NRC produces guidance for its licensees, and DOE produces guidance for its contractors. In addition, the NMMSS program produces a quarterly newsletter for all NMMSS users, which contains guidance on changes to nuclear material accounting policy and procedures.

- **Validation.** NMMSS completes automated validation checks for the completeness and accuracy of data on nuclear material transactions. There are two kinds of validation checks: (1) edit checks, which verify that the data are complete and properly formatted, and (2) compatibility checks, which verify that the shipper and receiver submit identical information about the obligation exchange. There are 550 separate types of edit checks and 74 types of compatibility checks. Validation checks control for data entry mistakes and omissions. Any errors identified through these checks can be corrected by NMMSS officials in consultation with authorized personnel at DOE sites and NRC-licensed facilities.
- **Reconciliation.** Reconciliation is the process of comparing NMMSS nuclear material inventory data with other records. Reconciliation occurs at two levels: at the facility level and at the country level. At the facility level, NMMSS officials compare facilities' reported physical inventory records—including their obligation balances—with the data in NMMSS and either confirm that these records are in agreement or alert facilities to make adjustments, if necessary.[38] A DOE order and NRC regulations require U.S. facilities to reconcile their nuclear material inventories—including their foreign obligation balances—at least once annually. DOE contractors must report their inventories to NMMSS by September 30 of each year and reconcile any discrepancies with NMMSS.[39] NRC licensees must report their inventories to NMMSS at least annually, depending on the type of material held, and reconcile any discrepancies with NMMSS. At the country level, NMMSS officials annually compare the inventory data with the records of foreign partners, including obligation balances. According to DOE officials, this inventory reconciliation process is conducted in accordance with the terms of certain administrative arrangements. Like reconciliation at the facility level, the officials told us that this process confirms whether NMMSS records are in

[38]According to DOE officials, if a facility's records are in disagreement with data in NMMSS, once the source of the disagreement has been identified the facility may submit an additional transaction form to NMMSS to "correct" its records. For example, if a facility reported the receipt of material to the NMMSS before the shipper facility had reported the same shipment, it may be necessary to submit an additional transaction form to NMMSS to correct and harmonize their respective nuclear material accounting records.

[39]According to DOE documents, NMMSS finalizes September accounting records after all DOE contractor inventories are reconciled no later than November 15th.

agreement with other records and alerts officials to follow up, if necessary.

- **Export records comparison.** A function in NMMSS compares foreign partners' export records with NMMSS data. Foreign partners provide advance notification, as well as a confirmation of shipment, to the U.S. government when shipping nuclear material to the United States. NMMSS then compares these communications, as well as foreign partners' export records obtained through IAEA, with data in NMMSS. Until January 2012, the communications were stored in documents, but since then, they have been recorded electronically in NMMSS.

We tested elements of these procedures and analyzed certain NMMSS data and found the data to be generally accurate with little evidence of inaccuracies or other problems with NMMSS data on obligation exchanges.[40] For instance, we tested several elements of the records of compatibility and edit checks for all 817 obligation exchanges to verify that the shipper and receiver submitted identical information to NMMSS for each obligation exchange. We found that nearly all information submitted by the shipper and receiver—such as material type, element weight, and obligation country code—was identical for each of the obligation exchanges conducted from October 1, 2003 through November 30, 2015.

However, we found two issues in NMMSS obligation exchange data. We discussed these issues with DOE and NRC officials, who indicated that they planned to take steps to address one of the identified issues and explained that that other issue had already been addressed.

- First, we found that according to NMMSS data, 2 of the 817 obligation exchanges conducted by NRC licensees involved uranium with assay levels of slightly more than 5 percent, which is contrary to NRC guidance that obligation exchanges are restricted to uranium enriched

[40]We also conducted interviews with senior agency officials to ensure that we fully understood the NMMSS data.

to 5 percent or less.[41] According to DOE and NRC officials, these exceeded levels were isolated anomalies and may have been due to rounding errors in NMMSS.[42] Nonetheless, as a result of our audit work, NMMSS officials stated that they intend to more closely monitor the potential exceedance of the 5 percent threshold by implementing a new edit check in NMMSS to identify obligation exchanges at licensed facilities on material with assay levels greater than 5 percent and flag that transaction as an error. According to NRC officials, the edit check will identify an error, which will prompt actions to resolve the transaction in NMMSS. Specifically, the licensee will have to consult with NMMSS program staff to determine whether the transaction requires additional U.S. approval before a manual authorization is given to override the error.

- Second, we found five obligation exchanges where the shipping facility and receiving facility reported different activity dates. According to one of NMMSS's compatibility checks, the date must be the same for the shipper and receiver of an obligation exchange.[43] However, NMMSS did not detect the mismatched data in these five obligation exchanges, which occurred from 2004 to 2009. According to DOE officials, the five obligation exchanges with mismatched dates were not caught in NMMSS because they predated an edit check that was implemented in NMMSS in March 2013. DOE officials said that, since the edit check was implemented 3 years ago, there have been no obligation exchanges with mismatched activity dates. DOE officials told us that this issue has been addressed.

[41]Uranium is categorized by concentration of uranium-235, expressed as a percentage "assay." According to DOE and NRC officials, obligated uranium-235 is restricted to uranium enriched to 5 percent or less, unless higher enrichment is authorized or approved by the U.S. government. The obligation exchanges involved uranium with assay levels of 5.05 and 5.13 percent.

[42]DOE and NRC officials stated that when facilities report LEU to NMMSS, they must report information to the nearest whole gram. These two exchanges involved a small amount of material, such that the precise weight was under the 5 percent assay but the rounded weight was higher than the 5 percent threshold specified in guidance (NRC NUREG/BR-0006 version 7).

[43]NNSA, *NMMSS 123 Agreement Communications Procedure*, June 26, 2014.

Conditions Exist That May Affect Agencies' Abilities to Use NMMSS to Demonstrate Compliance With Nuclear Cooperation Agreements and Monitor Unobligated Inventories Effectively

Two conditions exist that may affect DOE's and NRC's abilities to use NMMSS to demonstrate compliance with nuclear cooperation agreements and effectively monitor unobligated inventories. First, the agencies have not documented the conditions under which facilities may carry negative obligation balances. Second, the United States has a declining domestic inventory of unobligated LEU for national security purposes that is projected to last until 2038 to 2041, but NMMSS does not have a monitoring capability that could alert DOE when the inventory of unobligated LEU is particularly low.

Agencies Have Not Documented the Conditions under Which Facilities May Carry Negative Obligation Balances

Nuclear cooperation agreements and the administrative arrangements that we reviewed do not address whether or to what extent facilities may carry negative obligation balances but while DOE officials told us that the practice is not prohibited, DOE and NRC have not documented the conditions under which it is allowed. Negative obligation balances occur when a facility conducts an obligation exchange without having enough of a given nuclear material in inventory—similar to writing a check for an amount that is not currently in one's checking account, with the assumption that enough funds will be deposited in time to cover the cashing of the check.[44] DOE and NRC have not documented the conditions under which facilities are allowed to carry negative obligation balances.

Some NRC licensees stated that they carried negative balances for extended periods—including for several months or more than a year. DOE officials confirmed that certain facilities have carried negative obligation balances for brief periods, and others have carried them for extended periods of time. Specifically, according to DOE officials, 17 facilities in the United States have carried negative obligation balances between reconciliation dates.[45] DOE officials attributed 6 of 17 instances to facility "business practices." Specifically, they stated that certain

[44]Another way a negative obligation balance can occur is if a facility incorrectly assigns obligations—either too many or the wrong type—to a physical shipment of nuclear material.

[45]According to NNSA documents, of the 169 U.S. facilities that have obligated nuclear material, about 10 percent have had negative obligation balances and most of these were NRC-licensed facilities. Specifically, 15 were NRC-licensed facilities, and 2 were DOE sites.

facilities, such as uranium enrichment and fuel fabrication plants, need to deliver uranium with specific obligations to customers before they have physically obtained such uranium. As a result, the facilities may carry negative obligation balances for months at a time, with the assumption that sufficient obligations will be received on incoming shipments of nuclear material and that receipt of this material will eventually cover the negative obligation balance.

DOE officials attributed the negative obligation balances at 11 of the 17 facilities to the brief time lag in reporting information to NMMSS.[46] Specifically, the DOE/NRC Form 741 that officially records the obligation exchange must be sent by the "shipping" facility to NMMSS within 1 business day, and the form that officially records the receipt of the material must be sent by the "receiving" facility to NMMSS within 10 days. Thus, it is possible for a facility to temporarily carry a negative obligation balance within this 10-day window.

However, we found that 1 of the 11 facilities had a negative obligation balance that was of significantly longer than 10 days: this negative obligation balance of LEU lasted 18 months and spanned multiple reconciliation periods. Specifically, an NRC-licensed facility carried a negative balance of foreign obligated LEU from February 2006 to August 2007.[47] Representatives of the facility and DOE officials confirmed this negative obligation balance and that it lasted for about 18 months—spanning three reconciliation periods.[48] According to officials from the facility, to remedy its negative balance, in August 2007 the facility conducted an obligation exchange with another facility to obtain foreign obligated LEU. DOE officials told us that since 2010, there have been no other instances of negative obligation balances persisting at any facility past reconciliation. Nevertheless, since one negative obligation balance persisted past multiple reconciliation periods, a risk remains that facilities

[46]Of the 11 facilities DOE reported with a brief time lag, 6 had negative obligation balances of LEU and the remaining 5 facilities had negative obligation balances of natural uranium, depleted uranium, or plutonium.

[47]According to representatives from this NRC licensed facility, the facility incorrectly assigned too many obligations to physical shipments of nuclear material.

[48]DOE officials stated there were three reconciliation periods because NMMSS reconciles inventory records with this facility on a bi-annual basis.

may carry negative obligation balances for extended periods of time in the future.

Under federal standards for internal control, agency management should design control activities to achieve objectives and respond to risk, including by clearly documenting internal control, and the documentation may appear in management directives, administrative policies, or operating manuals.[49] While NNSA's procedures for foreign obligation reporting state that both the shipping and receiving facilities should verify that there is sufficient inventory of the given material type to support an obligation exchange, they do not document the conditions under which carrying a negative obligation balance is allowed.[50] Moreover, some NRC licensees told us that it is unclear whether or to what extent facilities may carry negative obligation balances. Representatives from one facility stated that it would be helpful for NMMSS officials to help clarify when the practice of carrying negative obligation balances is allowed and for what duration.

DOE officials told us they strongly encourage facilities to avoid carrying negative obligation balances but acknowledge that they have not documented in guidance when the practice is allowed. Specifically, DOE and NRC officials said that they discourage this practice through informational presentations that they provide to NRC licensees and DOE contractors at trainings and conferences. However, DOE officials told us that the practice of carrying negative obligation balances is not prohibited and that they have not documented the conditions under which carrying a negative obligation balance is allowed. Instead, DOE officials stated that their main internal control for negative obligation balances is to review facilities' inventory once each year as part of the annual reconciliation process. Through this process, NMMSS analysts expect facilities to correct any negative obligation balances by the time of reconciliation. However, as we noted, this process did not address the negative obligation balance carried by one facility through several reconciliation cycles. According to NNSA documents, additional internal control

[49]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[50]These procedures are described in an internal NNSA document for NMMSS analysts. See NNSA, *NMMSS 123 Agreement Communications Procedure*.

procedures have been implemented in NMMSS in the past 6 years—such as developing new edit checks to detect incidences of negative obligation balances at the time of reconciliation—which NNSA officials believe will prevent facilities in the future from carrying negative obligation balances past reconciliation. However, we were unable to test these internal controls to verify whether there have been any additional incidences of facilities carrying negative obligation balances past reconciliation.[51] As the inventory of LEU continues to decline, there is a growing risk that facilities carrying negative obligation balances between reconciliation periods may not be able to correct their negative obligation balances at year end. Without DOE and NRC clarifying in guidance the conditions under which facilities can carry negative balances, facilities may be at risk in the future of conducting exchanges that they ultimately cannot fulfill, putting the U.S. government at risk of not complying with its nuclear cooperation agreements.

NMMSS Does Not Have a Capability to Alert DOE When the Inventory of Unobligated LEU Is Particularly Low

NMMSS does not have a capability to alert DOE when the inventory of unobligated LEU is low, placing facilities with negative obligation balances at risk of not being able to reconcile them. According to NMMSS data, there have been significant decreases in the inventory of unobligated LEU, particularly from 2014 to 2015, which DOE officials attributed in part to the closure of the Paducah Gaseous Diffusion Plant in 2013, when the United States lost its sole supplier of unobligated LEU. DOE officials project that the inventory of unobligated LEU will continue to decrease without a domestic source. DOE documents estimate that the inventory will run out at some point from 2038 to 2041.[52]

Federal standards for internal control state that management should establish and operate monitoring activities to monitor the internal control

[51]Specifically, we were unable to compare data across years to determine how many facilities had carried negative obligation balances past reconciliation because certain obligation data in NMMSS include revisions to the original data entered in NMMSS.

[52]In light of this trend, Congress has taken an interest in the future supply of unobligated LEU. The House Armed Services Committee report accompanying H.R. 4909, the National Defense Authorization Act for Fiscal Year 2017, includes a provision for GAO to review and assess a recent report on DOE's enriched uranium management, including the ability of DOE to meet defense requirements for enriched uranium into the future and other matters related to domestic uranium enrichment. H.R. Rep. No. 114-537, at 393 (2016).

system and evaluate the results.[53] Ongoing monitoring is to be built into the entity's operations, performed continually, and responsive to change and may include automated tools, which can increase objectivity and efficiency by electronically compiling evaluations of controls and transactions. DOE officials acknowledged that they do not have a specific capability in NMMSS that could serve as an early-warning system to alert them when the inventory of unobligated LEU becomes low enough to put facilities at risk of running negative obligation balances that they may not be able to reconcile. They also told us that no such capability is currently needed because the inventory of unobligated LEU is currently sufficient to limit such risk. Moreover, DOE officials added that they would step in to cover a negative obligation balance that could not otherwise be covered out of a facility's own inventory, by transferring unobligated LEU from the U.S. national security inventory.

Nevertheless, while the U.S. national security inventory of unobligated LEU could be used to correct any future negative obligation balances, if the decline in this U.S. inventory of unobligated LEU continues, and if it is possible to carry a negative obligation balance beyond reconciliation, there is a risk that, at some point in the future, a facility may conduct an exchange for nuclear material that it cannot fulfill—essentially bouncing a check. DOE officials acknowledged that the decline in the national security inventory of unobligated LEU may change the way senior DOE officials need to use NMMSS in the future and that additional monitoring may be needed to ensure compliance with nuclear cooperation agreements. Without DOE and NRC developing an early-warning monitoring capability in NMMSS to alert senior DOE officials when the inventory of unobligated LEU becomes low, DOE cannot know when supplies of unobligated LEU are no longer available to correct negative obligation balances, thereby putting the U.S. government at risk of noncompliance with its nuclear cooperation agreements.

Conclusions

Under terms of its nuclear cooperation agreements, the United States must account for foreign obligated nuclear material, and NMMSS has been designated as the system to track and report on that material as it enters, leaves, and moves within the country. DOE and NRC have

[53]GAO-14-704G.

developed procedures designed to ensure that the transaction data in NMMSS, including data on obligation exchanges, are accurate. With the exception of a few issues, which NNSA has fixed or plans to fix by developing new internal controls, we found that these procedures are working as expected and that NMMSS data on obligation exchanges appear to be reliable.

Certain obligation exchange practices, combined with trends in the inventory of unobligated LEU, may change the information DOE and NRC officials need and the actions required to ensure compliance with nuclear cooperation agreements in the future. While DOE's procedures for foreign obligation reporting state that facilities should verify that there is sufficient inventory of the given material type to support an obligation exchange, neither the procedures nor other guidance document the conditions under which carrying a negative obligation balance is allowed. In addition, the United States has a declining domestic inventory of unobligated LEU, but NMMSS does not have an early-warning monitoring capability to alert DOE when this inventory is particularly low. Without such an early-warning monitoring capability in NMMSS to alert senior DOE officials when the inventory of unobligated LEU is particularly low, facilities carrying negative balances could put the U.S. government in the position of potential non-compliance with its nuclear cooperation agreements.

Recommendations for Executive Action

We are making two recommendations to the Under Secretary for Nuclear Security, as the Administrator of the National Nuclear Security Administration, and the Nuclear Regulatory Commission to help ensure compliance with the United States' nuclear cooperation agreements:

1. Clarify in guidance the conditions under which facilities may carry negative obligation balances.
2. Develop an early-warning monitoring capability in NMMSS to alert senior DOE officials when the inventory of unobligated LEU is particularly low.

Agency Comments and Our Evaluation

We provided drafts of this report to DOE, NRC, and TVA for review and comment. DOE and NRC provided written comments, which are summarized below and reproduced in appendix I and II, respectively. TVA did not comment on our findings and recommendations. In addition, all three agencies provided technical comments, which we incorporated as appropriate.

In their written comments, DOE and NRC did not explicitly state whether they concur with the recommendations. DOE and NRC described actions they are implementing or planning to implement to address our recommendations.

Concerning our first recommendation that DOE and NRC clarify in guidance the conditions under which facilities may carry negative obligation balances, NRC stated that it is currently reviewing its guidance on nuclear material reporting and will consider our recommendation when updating this guidance. We will continue to monitor NRC's implementation of this recommendation. DOE said that it is deferring to NRC's response on this recommendation. DOE also stated that NNSA has no authority to regulate negative balances that may occur as a result of commercial business practices. DOE's response suggests that it believes our recommendation was limited to NRC licensees engaged in commercial transactions. However, we recommended both NRC and NNSA develop guidance to clarify when facilities with materials under their jurisdiction may carry negative obligation balances because the practice of carrying negative obligation balances at either a NRC-licensed facility or DOE facility could put the United States in a position of noncompliance with international agreements in the future if balances of unobligated LEU become particularly low. Developing guidance could mitigate this risk.

Concerning our second recommendation that DOE and NRC develop an early-warning monitoring capability in NMMSS to alert senior DOE officials when the inventory of unobligated LEU is particularly low, DOE noted that it has been directed by Congress to biennially update its *Tritium and Enriched Uranium Management Plan through 2060*.[54] DOE stated it will address our recommendation through these updates, which will assess the inventory of unobligated enriched uranium for national security applications. We agree that updating the plan will help DOE monitor its inventory of unobligated LEU, and we acknowledge that for now, biennial updates to the plan may be sufficient to monitor the declining inventory of unobligated LEU. However, the inventory of unobligated LEU has rapidly declined in recent years—about 10 percent in 1 year alone—as noted in this report. As the inventory of unobligated LEU continues to decline, more frequent monitoring may be necessary to ensure that facilities do not conduct obligation exchanges for nuclear

[54]50 U.S.C. § 2538c (2016).

material that they cannot fulfill, which could put the United States at risk of noncompliance with its nuclear cooperation agreements. We continue to believe that our recommendation for DOE to develop an early-warning monitoring system will help mitigate the chance of DOE officials being unable to address a sudden decline in the inventory unobligated LEU. In its written response to our second recommendation, NRC stated that DOE has notified it that DOE will complete biennial updates to the plan and that NRC will support DOE as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report's date. At that time, we will send copies to the appropriate congressional committees, the NNSA Administrator, the Chairman of the Nuclear Regulatory Commission, TVA's Board of Directors, and other interested parties. In addition, this report will be available at no charge on the GAO website at http://www.gao.gov.

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

David C. Trimble
Director
Natural Resources
and Environment Team

Appendix I: Comments from the Department of Energy

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

September 14, 2016

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 (GAO) draft report "Nuclear Material: Agencies Have Sound Procedures for Managing Exchanges but Could Improve Inventory Monitoring" (GAO-16-713). We appreciate GAO's acknowledgment that the National Nuclear Security Administration (NNSA) has procedures in place to accurately track and report on obligation exchanges and that those procedures are generally reliable.

The report recommends NNSA and the Nuclear Regulatory Commission (NRC) clarify in guidance the conditions under which facilities can carry negative obligation balances. Current NRC policy requires each licensed facility to track material by type and ensure that exchanges do not result in negative obligations at the end of the reconciliation period dictated in the NRC license. Prior to the end of the reconciliation period, NNSA has no authority to regulate negative balances that may occur as a result of commercial business practices. NNSA defers to the NRC's response on this recommendation.

The report also recommends NNSA develop an early-warning monitoring capability in the Nuclear Materials Management and Safeguards System to alert senior officials when the inventory of unobligated low-enriched uranium (LEU) is particularly low. The most pressing national defense need for unobligated LEU is to fuel tritium production reactors. DOE/NNSA identified multiple options that are expected to extend the need date for additional unobligated LEU fuel out to 2038-2041. Further, we have been congressionally directed to provide biennial updates to the *Tritium and Enriched Uranium Management Plan* through 2060. The updates to this report will assess the status of the inventory of unobligated enriched uranium for national security applications. We will continue to closely monitor our unobligated LEU inventories and, should future estimates indicate that demand may exceed potential future inventories, we will notify senior leadership and evaluate options and strategies for meeting those requirements. NNSA considers this recommendation closed based on the established monitoring and reporting processes, which should provide sufficient lead time to address any projected needs for additional unobligated LEU.

Technical comments for your consideration have been provided under separate cover to enhance the clarity and accuracy of the report. If you have any questions regarding this response, please contact Dean Childs, Director, Audits and Internal Affairs, at (301) 903-1341.

Sincerely,

Frank G. Klotz

Appendix II: Comments from the Nuclear Regulatory Commission

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

September 8, 2016

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

Dear Mr. Trimble:

Thank you for providing the U.S. Nuclear Regulatory Commission (NRC) with the opportunity to review and comment on the U.S. Government Accountability Office's (GAO) draft report GAO-16-713, "Nuclear Material: Agencies Have Sound Procedures for Managing Exchanges but Could Improve Inventory Monitoring." The NRC has reviewed the report and has a few comments for GAO's consideration. Please see the comments in the enclosure to this letter.

The report recommends that the U.S. Department of Energy (DOE) and the NRC clarify in guidance when facilities can carry negative obligation balances. The NRC is currently reviewing its guidance on nuclear material reporting contained in NUREG/BR-0006, "Instructions for Completing Nuclear Material Transaction Reports," and NUREG/BR-0007, "Instructions for the Preparation and Distribution of Material Status Reports," and will consider GAO's recommendation when updating these documents. The report also recommends that DOE and the NRC develop an early-warning monitoring capability in the Nuclear Materials Management and Safeguards System to alert DOE when the inventory of unobligated low enriched uranium is particularly low. DOE has informed the NRC that it is committed to bi-annual updates to the Tritium and Enriched Uranium Management Plan to assess the status of the inventory of unobligated enriched uranium for national security applications, consistent with Congressional direction. The NRC will support DOE, as appropriate.

If you have any questions regarding the NRC's response, please contact Mr. John Jolicoeur by phone at (301) 415-1642 or by e-mail at John.Jolicoeur@nrc.gov.

Sincerely,

Victor M. McCree
Executive Director
for Operations

Enclosure:
As stated

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, Nathan Anderson (Assistant Director), Eric Bachhuber, and Tyler Kent made key contributions to this report. Also contributing to this report were Alison B. Bawden, Antoinette Capaccio, Julia Coulter, Kaitlin Farquharson, Ellen Fried, Cindy Gilbert, Mitch Karpman, Amanda K. Kolling, Jeff Philips, Dan C. Royer, and Vasiliki Theodoropoulos.