

**GAO**

Report to the Chairman, Subcommittee  
on Emerging Threats and Capabilities,  
Committee on Armed Services, U.S.  
Senate

November 2004

# NUCLEAR NONPROLIFERATION

DOE Needs to  
Consider Options to  
Accelerate the Return  
of Weapons-Usable  
Uranium from Other  
Countries to the  
United States and  
Russia



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# Highlights

Highlights of [GAO-05-57](#), a report to the Chairman, Subcommittee on Emerging Threats and Capabilities, Committee on Armed Services, U.S. Senate

## Why GAO Did This Study

Many foreign nuclear research reactors use highly enriched uranium (HEU) fuel. Because HEU can be used in nuclear weapons, the Department of Energy (DOE) has two programs to return HEU from foreign reactors to either the United States or Russia. The U.S. fuel acceptance program includes HEU exported by the United States to 34 countries, 11 of which have returned all of their HEU. The program also includes low enriched uranium (LEU) fuel, which would be very difficult to use in a nuclear weapon. DOE imposes a fee on high-income countries to partially offset the cost of disposing of HEU and LEU fuel in the United States. Under the Russian fuel return program, DOE assists in the return of Russian-origin HEU from 14 countries to Russia. GAO was asked to examine (1) the status of DOE efforts to recover remaining inventories of U.S.-origin HEU and the extent to which the fees imposed on high-income countries support these efforts, and (2) the cost and time frame for completing the Russian fuel return program.

## What GAO Recommends

GAO recommends that DOE (1) consider offering incentives to foreign research reactors to return HEU to the United States, including lowering fees for accepting HEU from high-income countries; and (2) evaluate raising fees for returning LEU to the United States to offset as much of the disposal costs as possible. DOE concurred with our recommendations.

[www.gao.gov/cgi-bin/getrpt?GAO-05-57](http://www.gao.gov/cgi-bin/getrpt?GAO-05-57).

To view the full product, including the scope and methodology, click on the link above. For more information, contact Gene Aloise at (202) 512-3841 or [aloisee@gao.gov](mailto:aloisee@gao.gov).

## NUCLEAR NONPROLIFERATION

# DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia

## What GAO Found

For a number of reasons, including the cost of converting reactors from HEU to LEU fuel, DOE has not reached agreement with reactor operators in 11 of the 23 countries that still have U.S.-origin HEU to return all of the HEU to the United States. In contrast, reactor operators in 12 of the countries either have signed contracts with DOE to return all of their U.S.-origin HEU or are developing their own means of disposal. DOE is considering offering incentives to foreign research reactors to return their HEU to the United States but so far has not determined what incentives it will offer and to which countries. DOE has not revised the fees imposed on high-income countries since establishing the fuel acceptance program in 1996. However, DOE reserved the right to change the fees in response to changes in circumstances. While lowering the fees for returning HEU may encourage additional reactors to participate in the program, DOE could recover a greater portion of the disposal costs by raising the fees for accepting LEU.

DOE plans to complete the Russian fuel return program by 2009 and estimates the program could cost about \$100 million, but this estimate and time frame may not be reliable because of uncertainties associated with planning future shipments. The shipments to date have all consisted of fresh (unused) HEU fuel, which DOE considers the highest priority for returning to Russia because it is more vulnerable to theft. DOE is facing delays in returning spent HEU fuel, which has been used in a reactor, in part because Russia is planning to conduct an environmental assessment for each shipment. DOE has asked Russia to conduct a single environmental assessment for the spent HEU fuel in all of the countries participating in the program to expedite future shipments of spent fuel, but so far Russia has not agreed to this. DOE is considering ways to accelerate the program that could also increase the cost of the program by more than \$30 million.

### Spent Research Reactor Fuel in Transport to a U.S. Disposal Facility



Source: DOE.

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## Abbreviations

DOE	Department of Energy
FRR SNF	Foreign Research Reactor Spent Nuclear Fuel Acceptance program
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IG	Office of Inspector General
LEU	low enriched uranium
MCC	Material Consolidation and Conversion project
NNSA	National Nuclear Security Administration
RERTR	Reduced Enrichment for Research and Test Reactors program
RRRFR	Russian Research Reactor Fuel Return program

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United States Government Accountability Office  
Washington, DC 20548

November 19, 2004

The Honorable Pat Roberts  
Chairman, Subcommittee on  
Emerging Threats and Capabilities  
Committee on Armed Services  
United States Senate

Dear Mr. Chairman:

Civilian nuclear research reactors around the world use and store highly enriched uranium (HEU) fuel. The reactors are used in medicine, agriculture, and industry and for basic scientific research. The United States and the Soviet Union began providing the HEU used by many of these reactors in the 1950s. HEU can also be used as a key component in making a nuclear weapon. As a result, the United States has a long-standing nonproliferation goal of reducing the amount of HEU that is used and stored at these reactors. To accomplish this goal, the Department of Energy (DOE) has established three programs: one program to convert the reactors from HEU to low enriched uranium (LEU) fuel, which is considered to be less of a proliferation threat because it is very difficult to use in nuclear weapons, and two related programs to take back HEU from foreign research reactors for safe storage and disposal in either the United States or Russia, depending on the HEU's origin.

We reported on DOE's progress in implementing the first program—the Reduced Enrichment for Research and Test Reactors (RERTR) program—in July 2004.<sup>1</sup> Since 1978, the goal of this program has been to get research reactors around the world to convert from HEU fuel to LEU fuel. In our report, we found, among other things, that 66 of the 105 research reactors included in the program continue to use HEU fuel for a number of reasons, including lack of funding for conversion to LEU and technical setbacks in developing LEU fuels to replace HEU. We recommended that DOE evaluate the costs and benefits of providing additional incentives to foreign research reactor operators to convert to LEU. DOE's two related

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<sup>1</sup>GAO, *Nuclear Nonproliferation: DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors*, [GAO-04-807](#) (Washington, D.C.: July 30, 2004).

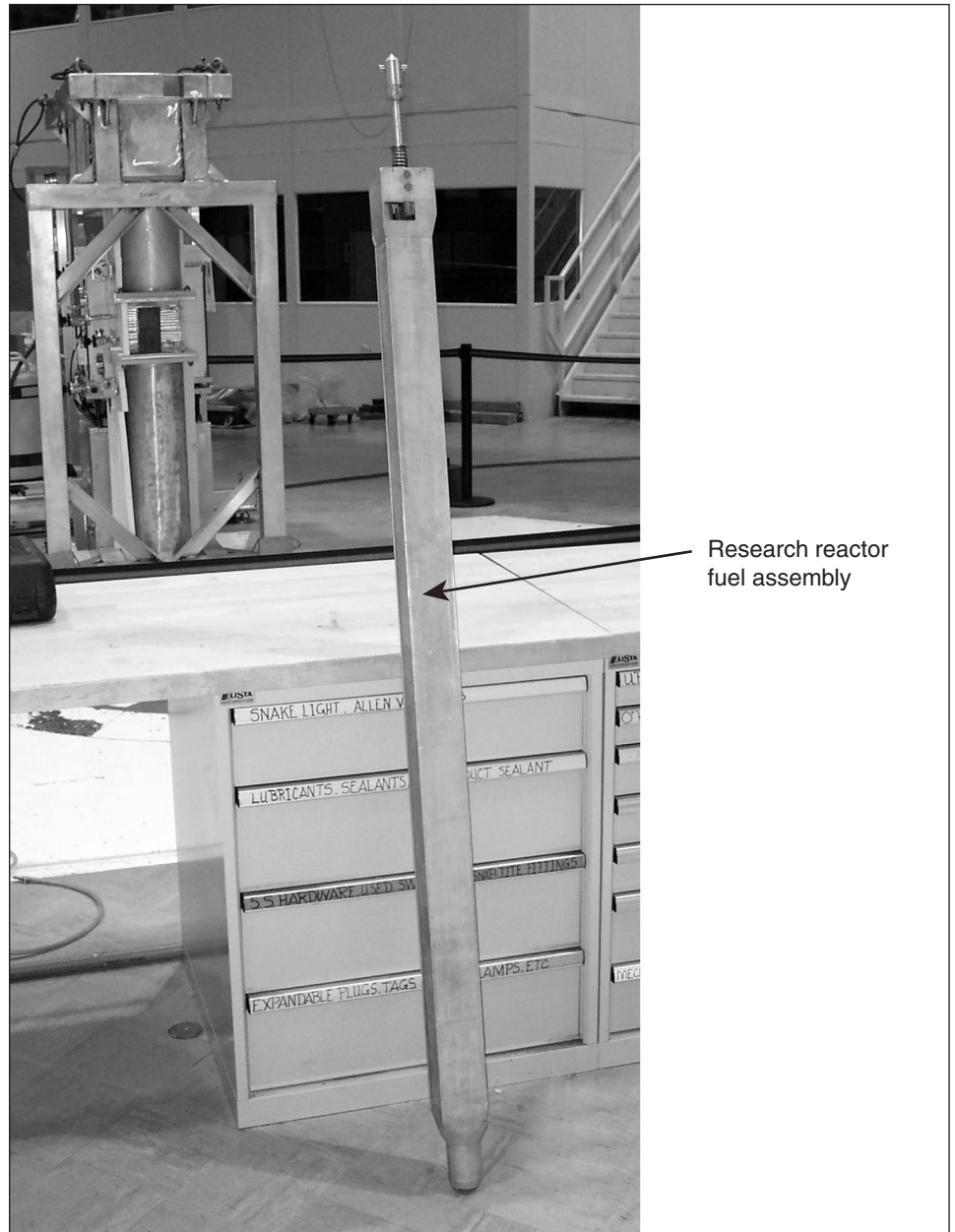
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programs for returning HEU to the United States or Russia are the Foreign Research Reactor Spent Nuclear Fuel Acceptance (FRR SNF) program, created in 1996, and the Russian Research Reactor Fuel Return (RRRFR) program.<sup>2</sup> DOE began discussions with Russia on the Russian fuel return program in 1999 and signed a bilateral agreement in 2004. Figure 1 shows an example of a fuel assembly used in a research reactor.

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<sup>2</sup>In this report, we refer to the FRR SNF program as the fuel acceptance program and the RRRFR program as the Russian fuel return program.

**Figure 1: Example of a Research Reactor Fuel Assembly**



Source: GAO.

DOE's fuel acceptance program is designed to return U.S.-origin HEU from 34 countries to the United States for safe storage and disposal and to encourage foreign research reactors to convert to LEU fuel. Currently, 11

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of the 34 countries have returned all of the HEU to the United States, and 23 still possess U.S.-origin HEU fuel. The scope of the fuel acceptance program includes an estimated 5,000 kilograms of HEU that the United States exported to research reactors in the 34 countries as well as an estimated 15,000 kilograms of LEU. DOE included LEU fuel in the scope of the program, even though LEU does not pose the same proliferation risk as HEU, because operators of many foreign research reactors had no other way to dispose of LEU fuel. Reactor operators need a means to dispose of spent fuel, and by including LEU in the fuel acceptance program, DOE provides operators of foreign research reactors with an assured means of disposing of spent fuel even after converting to LEU.

DOE imposes a fee on research reactors in high-income countries (as defined by the World Bank), such as the Netherlands and Japan, to offset as much as possible the cost of fuel disposal in the United States. The fees were not intended to cover the full cost of managing foreign research reactor spent fuel or the long-term cost of permanent disposal; DOE kept the fees low to encourage research reactor operators to participate in the program. DOE reserved the right to modify the fees at any time in response to a change in circumstances, including the cost of managing the fuel in the United States. The fees charged to reactors in high-income countries, which were established in 1996, do not exceed \$3,750 to \$4,500 per kilogram of LEU (depending on where in the United States the LEU is shipped) and \$4,500 per kilogram of HEU. DOE generally charges less for LEU fuel to avoid penalizing foreign reactors that convert to LEU. DOE does not impose fees on research reactors in non-high-income countries and, in addition, pays for most of the cost of transporting their spent fuel to the United States in order to encourage them to participate in the program.

DOE originally planned for the fuel acceptance program to end in 2009. DOE had anticipated that by 2009 operators of foreign research reactors would have made their own arrangements for managing U.S.-origin spent fuel, such as commercial reprocessing (a method for treating fuel prior to final disposal) or development of domestic disposal facilities, thereby eliminating the need to return the fuel to the United States. However, one of the LEU fuels developed by the RERTR program cannot be easily reprocessed, hindering efforts to dispose of spent LEU fuel other than by returning it to the United States. To assist foreign research reactors in developing other spent fuel management options, DOE's RERTR program is working to develop a new reprocessable LEU fuel that foreign reactor operators can switch to once it is developed and available commercially. In 2003, a group of foreign research reactor operators petitioned DOE to



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extend the program beyond 2009, citing technical setbacks in the development of a reprocessible LEU fuel. The reactor operators feared the expiration of DOE's fuel acceptance program and the delay in developing a new LEU fuel would leave reactors without a way to dispose of spent fuel. In April 2004, the Secretary of Energy announced his intention to extend the U.S. fuel acceptance program beyond the original 2009 end date. DOE is considering extending the program by 5 or 10 years to support the reactor operators that have converted their reactors to LEU.

DOE's final program, aimed at facilitating the return of HEU to Russia, has identified research reactors in 17 countries (mostly in the former Soviet Union and Eastern Europe) that have Russian-origin fuel. DOE pays the cost of transporting and disposing of HEU fuel in Russia. The Secretary of Energy has estimated that there are about 4,000 kilograms of Russian-origin fuel in the 17 countries.<sup>3</sup> So far, DOE has provided assistance to return about 100 kilograms of fresh (unused) HEU fuel from 5 countries (Bulgaria, Libya, Romania, Serbia, and Uzbekistan) for storage at two nuclear facilities in Russia—Dmitrovgrad and Novosibirsk. In addition, DOE plans to pay Russia to “blend down” the HEU returned to Dmitrovgrad to LEU, thereby reducing the risk that the material could be used in a nuclear weapon. In return, operators of foreign research reactors with Russian-origin HEU fuel must agree to shut down or convert their reactors to LEU.

In response to your request, we examined DOE efforts to recover HEU fuel from foreign research reactors and assessed (1) the status of DOE efforts to return remaining inventories of U.S.-origin HEU for storage and disposal in the United States and the extent to which the fees DOE imposes on high-income countries support these efforts, and (2) DOE's estimate of the cost and time frame for completing the Russian fuel return program.

To address these objectives, we analyzed documentation from both programs, including inventories of HEU fuel and data on fuel returned to date. We also analyzed DOE data on expenditures in support of the fuel acceptance program and fees paid by reactors in high-income countries to return their fuel to the United States. To obtain information on how the program is working, we interviewed operators of research reactors in Belgium, Germany, the Netherlands, Poland, Portugal, Romania, and

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<sup>3</sup>According to a DOE official, this estimate includes LEU fuel in Serbia.

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Ukraine. We discussed the status of the programs with DOE and Russian officials and with officials in the other countries we visited. We conducted our review from July 2003 to October 2004 in accordance with generally accepted government auditing standards.

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## Results in Brief

DOE has not reached agreement with research reactor operators in 11 of the 23 countries that still have U.S.-origin HEU to return all of the HEU to the United States. Reactor operators in the 11 countries have not made arrangements to return the HEU for a number of reasons, including the cost of conversion to LEU. For example, some reactor operators are planning to use their HEU, despite DOE's efforts to encourage them to convert their reactors to LEU fuel and return the HEU fuel to the United States, because they do not want to incur the expense of paying for conversion. In addition, in some high-income countries such as Austria, the cost of returning the HEU (including transportation) may be a factor in not making plans to return the material to the United States. DOE is considering offering further incentives to reactor operators to convert to LEU and return their HEU to the United States but thus far has not determined what incentives it will offer and to which countries. Finally, informal diplomatic approaches to discuss the return of HEU from research reactors in Iran and Pakistan have been unsuccessful. In contrast, operators of reactors in 12 of the 23 countries that still have U.S.-origin HEU either have signed contracts with DOE to return all of the HEU to the United States by 2009 or are developing their own means to dispose of HEU fuel. We recommend that DOE consider offering incentives to foreign research reactors to return HEU to the United States, including lowering the fees for returning HEU.

Furthermore, while DOE has proposed extending the time frame of the fuel acceptance program by 5 or 10 years, it has not revised the fees it charges to research reactors in high-income countries since establishing the program in 1996. DOE set the fees at a level to encourage the reactors to convert to LEU fuel and return HEU rather than to cover the disposal cost in the United States. However, when DOE set the fees, it reserved the right to change them in response to changes in circumstances. For example, with the proposed extension of the program, the United States would accept larger quantities of LEU from foreign research reactors than originally planned. According to DOE and State Department officials, failure to extend the fuel acceptance program would penalize operators of research reactors that the United States encouraged to convert to LEU because the only currently available option for disposing of the type of LEU fuel used by some reactors is returning it to the United States.

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Nevertheless, the proposed extension could justify an increase in the fees charged to high-income countries. While lowering the fees for returning HEU may encourage additional countries to participate in the program, DOE could recover a greater portion of the cost of the program by raising the fees for accepting LEU. We recommend that DOE evaluate raising the fees for countries returning LEU to the United States.

DOE plans to complete the Russian fuel return program by 2009 and estimates the program could cost about \$100 million, but this estimate and time frame may not be reliable because of uncertainties associated with planning future shipments. The shipments to date have all consisted of fresh (unused) HEU fuel, which DOE considers the highest priority for returning to Russia because it is less radioactive than spent fuel and therefore easier to handle and potentially steal. DOE has targeted four more countries for removal of fresh HEU by 2005. However, DOE has not provided assistance to return spent HEU fuel to Russia from any of the countries. The Russian fuel return program is facing delays in returning spent fuel because Russia is planning to conduct an environmental assessment for each shipment, and complex negotiations are needed to arrange some shipments. DOE has asked Russia to conduct a single environmental assessment for all spent fuel in all the countries that are participating in the program, which would help expedite future shipments of spent fuel, but so far Russia has not agreed to this. DOE officials said they expect shipments of spent fuel, which is more difficult to dispose of, to cost more than fresh fuel shipments. While DOE has spent about \$1.5 million in support of four of the shipments of fresh HEU fuel, Russia's estimate of the transportation and disposal costs for the first shipment of spent fuel, from Uzbekistan, is \$5.7 million. Furthermore, according to DOE officials, Russia has not agreed to a fixed fee for accepting future shipments of spent fuel because the costs of managing the fuel in Russia could increase. DOE is considering ways to accelerate the Russian fuel return program, such as purchasing a cask with a larger capacity for transporting HEU fuel than currently available casks and developing a new technology to dilute spent HEU fuel into LEU before shipping it to Russia. DOE officials estimate that these options could also increase the cost of the program by more than \$30 million.

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## Background

Civilian nuclear research reactors located throughout the world contribute to the development of nuclear power, basic and applied science, and isotope production for medicine and industry. While many of the reactors use LEU fuel, others use or have inventories of HEU. The fuel acceptance program and Russian fuel return program are part of the Global Threat

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Reduction Initiative announced by the Secretary of Energy in a speech on May 26, 2004, to secure, remove, or dispose of a broad range of nuclear and radiological materials that are vulnerable to theft. The programs also benefit foreign research reactors by providing them with a way to dispose of spent fuel.

DOE's fuel acceptance program identified 34 countries with U.S.-origin HEU eligible for return to the United States. Research reactors in 11 of the 34 countries have returned all of the HEU to the United States. In the remaining 23 countries, 11 have returned a portion of their U.S.-origin HEU, and 12 have not returned any HEU (see fig. 2). In total, DOE estimates it has recovered 914 kilograms of HEU fuel, enough to build an estimated 20 nuclear weapons.<sup>4</sup> (See app. I for a list of the countries that have returned HEU and LEU fuel to the United States and the amount returned.)

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<sup>4</sup>The estimate of the number of nuclear weapons is based on the amount of the isotope uranium-235 in the HEU fuel.

**Figure 2: 34 Countries with U.S.-origin HEU Included in DOE’s Fuel Acceptance Program**

11 countries that have returned all of their U.S.-origin HEU	11 countries that have returned a portion of their U.S.-origin HEU	12 countries that have not returned any U.S.-origin HEU
Brazil	Argentina	Belgium <sup>a</sup>
Chile	Australia <sup>a</sup>	France <sup>a</sup>
Colombia	Austria <sup>a</sup>	Indonesia
Denmark <sup>a</sup>	Canada <sup>a</sup>	Iran
Italy <sup>a</sup>	Germany <sup>a</sup>	Israel <sup>a</sup>
Philippines	Greece	Jamaica
Slovenia	Japan <sup>a</sup>	Mexico
Spain <sup>a</sup>	Netherlands <sup>a</sup>	Pakistan
Sweden <sup>a</sup>	Romania	Portugal
Switzerland <sup>a</sup>	South Korea	South Africa
Thailand	Taiwan <sup>a</sup>	Turkey
		United Kingdom <sup>a</sup>

Source: DOE.

Notes: In addition to the 34 countries with U.S.-origin HEU, the United States exported LEU (but not HEU) to 7 countries—Bangladesh, Congo, Finland,<sup>a</sup> Malaysia, Peru, Uruguay, and Venezuela. The amount of HEU exported to some of the countries is small. For example, Indonesia has a small amount of HEU used for the production of medical isotopes as well as LEU fuel (but not HEU fuel), and the research reactor in Jamaica has only a small amount of HEU fuel located in the core of the reactor.

<sup>a</sup>High-income countries at the beginning of the fuel acceptance program in 1996. According to DOE officials, Greece, Portugal, and South Korea are now also considered high-income countries.

The fuel returned to the United States is mostly stored at DOE’s Savannah River Site, with a small portion also stored at DOE’s Idaho National Engineering and Environmental Laboratory. DOE anticipates that it will ship the fuel to the geologic repository at Yucca Mountain in Nevada for final disposal, assuming the facility is completed as planned. DOE completed an environmental impact statement and established the fuel acceptance program in 1996.<sup>5</sup> The fuel acceptance program is a

<sup>5</sup>Prior to DOE’s establishment of the fuel acceptance program, GAO issued a report in March 1994 recommending that DOE complete environmental requirements and begin accepting spent fuel from foreign research reactors. See GAO, *Nuclear Nonproliferation: Concerns with U.S. Delays in Accepting Foreign Research Reactors’ Spent Fuel*, [GAO/RCED-94-119](#) (Washington, D.C.: Mar. 25, 1994).

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continuation of previous programs that allowed foreign research reactors to dispose of U.S.-origin fuel in the United States.

In a February 2004 review, DOE's Office of Inspector General (IG) found that DOE was likely to recover about half of the HEU eligible under the fuel acceptance program, in part because the participation of countries with U.S.-origin fuel is voluntary and some countries have chosen not to participate.<sup>6</sup> Furthermore, the IG found that the program did not include another 12,300 kilograms of HEU that the United States had exported because DOE, when establishing the fuel acceptance program in 1996, limited the types of fuel that would be eligible for return. The IG recommended that DOE determine whether the fuel acceptance program should be expanded to include all HEU exported by the United States and whether improvements could be made to encourage greater participation of countries that have HEU fuel covered by the program. The IG also recommended that DOE determine whether the National Nuclear Security Administration (NNSA) could more effectively manage the program, which is currently being managed by DOE's Office of Environmental Management. In response, the Secretary of Energy announced that the program would be transferred to NNSA and combined with DOE's Russian fuel return program, already being managed by NNSA. According to DOE officials, DOE plans to address, through a separate program, the IG recommendation regarding U.S.-origin HEU not currently covered under the fuel acceptance program because returning additional inventories of HEU to the United States would require an analysis of environmental impacts, including how the material would be stored. DOE officials said they do not want to delay the proposed extension of the fuel acceptance program in order to allow time to conduct such an analysis.

DOE has identified 17 countries with Russian-origin fuel, 14 of which have HEU fuel that DOE has included under the Russian fuel return program. The 14 countries are Belarus, Bulgaria, the Czech Republic, Germany, Hungary, Kazakhstan, Latvia, Libya, Poland, Romania, Serbia, Ukraine,

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<sup>6</sup>DOE IG, *Recovery of Highly Enriched Uranium Provided to Foreign Countries*, DOE/IG-0638 (Washington, D.C.; Feb. 9, 2004).

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Uzbekistan, and Vietnam.<sup>7</sup> Two countries, Germany and Romania, have both U.S.-origin and Russian-origin HEU fuel.

DOE has provided funding and technical assistance for shipments of about 100 kilograms of fresh HEU fuel to Russia from 5 countries—Bulgaria, Libya, Romania, Serbia, and Uzbekistan. (The State Department and the Nuclear Threat Initiative, a private foundation, also participated in the removal of HEU from Serbia.) The fresh HEU fuel from Bulgaria, Libya, Serbia, and Uzbekistan was shipped to the Research Institute of Atomic Reactors in Dmitrovgrad for downblending into LEU to reduce the risk of the material being used in a nuclear weapon.<sup>8</sup> As of October 2004, DOE had signed a contract with Dmitrovgrad to downblend the HEU from Serbia and was negotiating contracts to downblend the HEU from Bulgaria, Libya, and Uzbekistan. A DOE official estimated that Dmitrovgrad would complete the downblending of the HEU from Serbia by spring 2005, after resolving technical difficulties encountered in the downblending process. DOE officials said that the HEU fuel from Romania was sent to the Novosibirsk site in Russia, because the Dmitrovgrad facility did not have the technical capability to downblend the HEU fuel from Romania. (Table 1 summarizes the five shipments of fresh HEU to Russia.)

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<sup>7</sup>According to DOE officials, three other countries—China, Egypt, and North Korea—have Russian-origin research reactor fuel but are not likely candidates for the program—China because it is a nuclear weapons state, Egypt because it possesses only LEU, and North Korea because of its development of nuclear weapons.

<sup>8</sup>The downblending is part of DOE's Material Consolidation and Conversion (MCC) project, which pays to downblend HEU currently stored at sites in Russia into LEU. For more information on the MCC project, part of DOE's program for improving the security over weapons-usable nuclear material in Russia, see GAO, *Nuclear Nonproliferation: Security of Russia's Nuclear Material Improving; Further Enhancements Needed*, GAO-01-312 (Washington, D.C.: Feb. 28, 2001).

**Table 1: Shipments of Fresh HEU Fuel to Russia**

Country	Date shipped	Amount (kilograms)	Status
Serbia	August 2002	48	In storage at Dmitrovgrad Anticipated to be downblended to LEU by spring 2005
Romania	September 2003	14	Cannot be downblended at Dmitrovgrad; sent to Novosibirsk instead
Bulgaria	December 2003	17	In storage at Dmitrovgrad Contract for downblending under negotiation
Libya	March 2004	16	In storage at Dmitrovgrad Contract for downblending under negotiation
Uzbekistan	September 2004	3	In storage at Dmitrovgrad Contract for downblending under negotiation

Sources: DOE and International Atomic Energy Agency.

Unlike DOE's fuel acceptance program, the Russian fuel return program does not include LEU fuel because DOE does not consider LEU a proliferation risk. DOE cooperates with the International Atomic Energy Agency (IAEA) and the State Department to implement the Russian fuel return program. For example, IAEA conducts fact-finding missions in preparation for fuel shipments with assistance from DOE.

## Eleven of the 23 Countries with U.S.-Origin HEU Do Not Have Plans to Return It to the United States or Dispose of It Domestically

DOE has not reached agreement with research reactor operators in 11 of the 23 countries that still have U.S.-origin HEU to return all of the HEU to the United States. The reactor operators have not made arrangements to return the HEU for a number of reasons, including the cost of conversion to LEU. DOE is considering offering incentives to reactor operators to convert to LEU and return their HEU to the United States but thus far has not determined what incentives it will offer and to which countries. In contrast, reactor operators in 12 of the 23 countries that still have U.S.-origin HEU either have signed contracts with DOE to return all of the HEU to the United States by 2009 or are developing their own means to dispose of HEU fuel.

DOE has proposed extending the fuel acceptance program by 5 or 10 years, but the fees imposed on research reactors in high-income countries



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have not been changed since 1996. According to DOE and State Department officials, DOE's proposed extension of the time frame of the fuel acceptance program would benefit operators of research reactors that the United States encouraged to convert to LEU because the only currently available option for disposing of the type of LEU fuel used by some reactors is returning it to the United States. The extension of the program will primarily result in more LEU being returned to the United States by reactors that have converted to LEU fuel that cannot be reprocessed. DOE set the fees at a level to encourage reactor operators to convert to LEU fuel and return HEU rather than to cover the disposal cost in the United States. However, DOE reserved the right to change the fees in response to changes in circumstances.

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**Countries Are Not Returning All of the HEU because They Are Planning to Use It in Research Reactors or Lack Funding**

Operators of research reactors in 11 of the 23 countries that still have U.S.-origin HEU have not made arrangements to return the HEU for a number of reasons. (Table 2 lists the 11 countries that do not have plans to return all of their U.S.-origin HEU and the current status of any decision to participate in the fuel acceptance program.) Research reactors in some of the countries do not plan to continue using the HEU but have not reached an agreement with DOE on returning it to the United States. For example, according to a DOE official, the operator of a university research reactor in Austria would like to return its HEU to the United States but lacks funding for transportation. According to the official, DOE hopes to combine Austria's remaining HEU with a shipment of spent fuel from Greece or Turkey to reduce the transportation cost to the operator of the Austrian reactor.

**Table 2: Countries That Do Not Currently Have Plans to Return All U.S.-Origin HEU**

Country	Status
Austria	One research reactor has returned all of its HEU to the United States, but two additional reactors still have HEU—one has shut down but not finalized plans for returning HEU, and another has not made a decision to complete conversion to LEU and return HEU
Indonesia	Research reactor has agreed to stop using HEU for medical isotope production by 2006 and return LEU fuel, but plans for returning HEU are not finalized
Iran	Research reactor has converted to LEU but there are no plans to return HEU
Israel	No plans to convert research reactor to LEU and return HEU
Jamaica	No plans to convert research reactor to LEU and return HEU
Japan	Most Japanese research reactors are returning HEU, but two reactors do not have plans to convert to LEU and return HEU
Mexico	No plans to convert research reactor to LEU and return HEU
Pakistan	Research reactor has converted to LEU but there are no plans to return HEU
South Africa	Conversion of research reactor to LEU is under consideration
South Korea	Research reactor has shut down and returned spent HEU fuel but not agreed to return fresh HEU
Turkey	Conversion of research reactor to LEU is under consideration (reactor has partially converted)

Sources: DOE and State Department.

Other research reactor operators have not made a decision to convert their reactors to LEU. For example, operators of research reactors in Jamaica and Mexico may continue using their HEU fuel, which is sufficient to last many years. Similarly, while most research reactors in Japan have returned U.S.-origin HEU fuel, two Japanese research reactors have not made plans to convert to LEU fuel and participate in the fuel acceptance program. As we reported in our July 2004 review of the RERTR program, while operators of some foreign research reactors have agreed to fund conversion of their reactors from HEU to LEU, others either do not want to incur the additional cost of conversion or do not have the necessary funding.<sup>9</sup> Research reactor operators in South Africa and Turkey are considering converting to LEU, which could lead to returning U.S.-origin HEU to the United States. (The research reactor operator in Turkey has partially converted the reactor to LEU fuel but must completely convert before it can return its HEU. However, the reactor operator does not currently have the LEU fuel needed to complete the conversion process.)

<sup>9</sup>Many research reactors are designed to operate on a small amount of fuel meant to last the life of the reactor, and conversion would require purchasing LEU fuel and disposing of HEU fuel that the reactor operator already purchased and is still usable.

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In Iran, Israel, and Pakistan, DOE relies on State Department diplomatic efforts to encourage the countries to participate in the fuel acceptance program. Each of the three countries has one research reactor with U.S.-origin HEU fuel. The research reactors in Iran and Pakistan have converted to LEU fuel, but according to a State Department official, informal approaches to discuss the possible return of HEU from these two countries have been unsuccessful. The official said that recovering the HEU from Iran and Pakistan would require a political breakthrough similar to ones that enabled DOE to facilitate the removal of HEU from Serbia and Libya under the Russian fuel return program in August 2002 and March 2004, respectively. The State Department official said that the operators of the Israeli research reactor have expressed interest in converting their reactor to LEU, which would be the first step in possibly returning the HEU to the United States. However, the Nuclear Suppliers Group, the international body that governs the export of nuclear technologies, prohibits the export of LEU fuel to Israel.<sup>10</sup> Therefore, unless the reactor shuts down, it will likely continue to use its supply of HEU fuel rather than return it to the United States.

DOE is considering whether to offer additional incentives to the reactor operators that have not agreed to return HEU to the United States to encourage their participation in the fuel acceptance program. According to a State Department official, such incentives could influence some research reactors that are not participating in the fuel return program to return their HEU to the United States. For example, DOE could offer to purchase LEU fuel to replace HEU fuel that is still being used in the reactors. The State Department official said that if a research reactor agrees to shut down rather than convert to LEU, DOE could offer other incentives, such as research grants.

Operators of research reactors in 12 of the 23 countries that still have U.S.-origin HEU fuel have either agreed to return the material to the United States or are developing alternative disposal options. DOE officials said they have signed contracts with reactor operators in Australia, Germany, Greece, Portugal, Romania, and Taiwan to return their U.S.-origin HEU to

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<sup>10</sup>The aim of the Nuclear Suppliers Group guidelines is to ensure that nuclear trade for peaceful purposes does not contribute to the proliferation of nuclear weapons. The guidelines stipulate that certain items, including LEU, not be transferred to countries such as Israel that have not agreed to full-scope IAEA safeguards. For more information, see GAO, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes*, [GAO-03-43](#) (Washington, D.C.: Oct. 25, 2002).

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the United States by 2009, the original end date of the fuel acceptance program. As part of these arrangements, the reactor operators in these countries have agreed to convert to LEU fuel or shut the reactors down by 2006. For example, Australia is building a new research reactor that uses LEU fuel to replace an older research reactor, scheduled to be shut down, that previously used HEU. The reactor operator in Romania has agreed to return its HEU after it receives new LEU fuel, which is currently being manufactured, to replace the HEU. Six countries—Argentina, Belgium, Canada, France, the Netherlands, and the United Kingdom—are developing alternatives to disposing of U.S.-origin HEU in the United States. DOE officials said they support the efforts of these countries to develop their own means of disposal. For example, Argentina has reached an agreement with DOE to blend down part of its remaining inventory of U.S.-origin HEU for fabrication into LEU fuel for use in Argentina's research reactors. As part of this agreement, the one remaining research reactor in Argentina that currently uses HEU fuel will convert to LEU fuel and ship its HEU fuel to the United States. In Belgium, a reactor operator is sending spent U.S.-origin HEU fuel to France for reprocessing, which includes diluting the HEU into LEU and returning radioactive waste to Belgium for long-term disposal in an underground repository. As another example of a country that is developing an alternative means of disposal, the Netherlands has returned some of its U.S.-origin HEU and also completed a storage facility in 2003 for the disposal of nuclear waste, including spent fuel from research and power reactors located in the country. The facility is designed to store the spent fuel for 100 years (see fig. 3).

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**Figure 3: Facility in the Netherlands for Storage of Spent Fuel from Research and Power Reactors**



Source: COVRA, The Netherlands.

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## DOE Has Not Revised Fees to Account for Changes in the Fuel Acceptance Program

DOE has not revised the fees it charges to research reactors in high-income countries since 1996. DOE reserved the right to change these fees if circumstances changed, and in fact, a number of changes will affect the costs of the program.<sup>11</sup> Among the changes that will affect the costs of the fuel acceptance program is the proposed extension of the program, which would primarily result in more LEU being returned to the United States by reactors that have converted to LEU fuel that cannot be reprocessed. According to DOE and State Department officials, DOE's proposed extension will help reactor operators that the United States encouraged to convert to LEU because the only currently available option for disposing of the LEU fuel (other than in countries such as the Netherlands that have developed their own means of disposal) is returning it to the United States. For example, research reactor operators in Australia, Germany, Japan, and Sweden petitioned DOE to extend the program beyond 2009, so that they would have a way to dispose of LEU fuel. A number of the reactor operators have either converted to LEU fuel or, in the case of Australia,

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<sup>11</sup>The fees do not cover all of the costs of managing spent fuel from foreign research reactors, including the long-term cost of maintaining the fuel in storage at the facilities in South Carolina and Idaho and transporting the fuel to the planned final repository at Yucca Mountain.

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are building a new research reactor that uses LEU fuel to replace an older reactor that used HEU fuel.

DOE's primary objective when setting the fees in 1996 was to keep them low enough to encourage research reactors to return HEU to the United States rather than to cover the full cost of disposing foreign research reactors' spent fuel in the United States. For example, DOE set the fees at a rate competitive with the estimated cost of reprocessing, so that reactor operators would choose to participate in the program rather than reprocess spent fuel. Furthermore, DOE set the fees it charges for accepting LEU from research reactors in high-income countries at a level to encourage the reactors to convert to LEU. However, DOE also decided when setting the fees that it would try to recover as much of the cost of managing spent fuel from foreign research reactors as possible. For this reason, DOE reserved the right to revise the fees in response to changes in circumstances, including the cost of managing spent fuel in the United States. The fees paid by research reactors in high-income countries have covered about 84 percent of DOE's expenditures for the fuel acceptance program through fiscal year 2004. From fiscal year 1996 through fiscal year 2004, DOE received \$97.3 million in fees from research reactors in high-income countries for disposal of HEU and LEU fuel in the United States.<sup>12</sup> In comparison, DOE estimates that it spent \$116.1 million from fiscal year 1996 through fiscal year 2004 to implement the fuel acceptance program. These expenditures include the cost of transporting spent fuel from research reactors in non-high-income countries and part of the cost of operating the facilities where fuel is placed in interim storage but not the permanent disposal costs. (See app. I for a list of the fees paid by research reactors in high-income countries.) DOE officials agreed that given changes in the fuel acceptance program, including the proposed extension of the program by 5 or 10 years, reassessing the fees charged to research reactors in high-income countries is warranted.

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<sup>12</sup>Dollars are in constant fiscal year 2004 dollars.

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## DOE Plans to Complete the Return of HEU to Russia by 2009 at a Cost of about \$100 Million

DOE plans to complete the Russian fuel return program by 2009 and estimates the program could cost about \$100 million, but this estimate and time frame may not be reliable because of uncertainties associated with planning future fuel shipments. The program is facing delays in returning spent HEU fuel because Russia is planning to conduct an environmental assessment for each shipment of spent HEU fuel, and complex negotiations are needed to arrange some shipments. DOE supports Russia's efforts to examine the environmental impacts of returning spent HEU fuel to Russia. DOE has asked Russia to conduct a single environmental assessment for all spent fuel in all of the countries participating in the program, which would help expedite future shipments of spent fuel, but so far, Russia has not agreed to this. Furthermore, according to DOE officials, Russia has not agreed to a fixed fee for accepting future shipments of spent fuel because the costs of managing the fuel in Russia could increase. DOE is considering ways to accelerate the Russian fuel return program that could also increase the cost of the program by more than \$30 million.

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## DOE's Cost Estimate Is Uncertain because Russia Plans to Set the Price for Shipments of Spent HEU Fuel on a Case-By-Case Basis

DOE's estimate for completing the program for \$100 million is subject to a number of uncertainties, including the cost of returning spent HEU fuel to Russia. DOE officials said they expect shipments of spent fuel, which is more difficult to dispose of, to cost more than fresh fuel shipments. For example, Russia's estimate of the transportation and disposal costs for the shipment of spent fuel from Uzbekistan is \$5.7 million. This amount includes the cost of transportation, security, and storage of the spent HEU fuel in Russia as well as a spent fuel management fee, which pays for improvements to store the fuel in an environmentally safe manner. According to DOE officials, Russia has not agreed to a fixed fee for accepting future shipments of spent fuel because the costs of managing the fuel in Russia could increase. While DOE officials said the fees paid to Russia do not include profit, the terms of the agreement between DOE and Russia stipulate that the United States or a third party will pay the costs of returning HEU to Russia.

On the other hand, the cost of returning fresh HEU fuel to Russia is more certain. DOE officials estimate that each shipment generally costs about \$400,000. In addition, the DOE official in charge of the Material Consolidation and Conversion project, which pays for downblending the HEU fuel shipped to Dmitrovgrad in Russia, said that DOE has a stable

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price that it pays for downblending the fuel into LEU. DOE's Russian fuel return program has so far spent about \$1.5 million in support of four of the shipments of fresh HEU fuel to Russia.<sup>13</sup>

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## Environmental Assessments and Other Factors Could Cause Delays

One of the main uncertainties in DOE's plan to complete the Russian fuel return program by 2009 is the schedule for shipping spent HEU fuel to Russia. DOE has not yet provided assistance to return spent HEU fuel.<sup>14</sup> According to DOE officials, the main obstacle is Russia's requirement that an environmental assessment be conducted prior to each shipment of spent fuel, which has been irradiated in a reactor and is therefore more radioactive and difficult to dispose of than fresh fuel. For example, DOE signed an agreement with Uzbekistan in March 2002 to begin work on returning spent HEU fuel to Russia, but as of July 2004, the Russian government had not completed the environmental assessment for the shipment. Russian officials told us that future environmental assessments would take less time. However, if a similar amount of time is required for future assessments, spent fuel shipments could be delayed. DOE officials said they have asked the Russian government to conduct a single environmental assessment for the entire scope of the program in order to expedite future shipments of spent fuel. Such an assessment could be similar to the one DOE conducted prior to initiating the U.S. fuel acceptance program. DOE's assessment conducted for the fuel acceptance program identified the major components required to complete the program, including the total amount of HEU fuel, U.S. ports where the fuel would be shipped, and where and how the fuel would be disposed of. However, so far the Russian government has not agreed to such an assessment.

The schedule for the Russian fuel return program also depends on the level of cooperation in the countries where Russian-origin HEU fuel is located. In coordination with Russia and IAEA, DOE prioritized shipments

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<sup>13</sup>The State Department also provided about \$2 million to return fresh HEU from Serbia. This amount included the cost of transportation as well as funding for Dimitrovgrad to conduct research to overcome technical difficulties with downblending the material to LEU. The Nuclear Threat Initiative, a private foundation, contributed \$5 million to address safety and environmental problems at the facility in Serbia where the HEU was stored in exchange for participating in the Russian fuel return program. DOE did not provide information on its expenditures in support of the shipment of fresh HEU fuel from Uzbekistan.

<sup>14</sup>The five shipments to date have all consisted of fresh HEU fuel.



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of fresh HEU to Russia based on the amount of HEU located at a facility and security concerns in the region. However, DOE officials said they have acted quickly to take advantage of opportunities that arise to remove HEU fuel from a facility. For example, DOE removed fresh HEU fuel from Libya in March 2004, after the country unexpectedly agreed to participate in the program. Similarly, Romanian officials told us that high-level support within the Romanian government for the Russian fuel return program resulted in the shipment of HEU taking place very quickly. DOE officials said that other countries with Russian-origin HEU might be reluctant to participate in the Russian fuel return program. For example, DOE officials said they had encountered difficulties in negotiating with Belarus and Kazakhstan on returning their inventories of HEU to Russia. A Russian official also told us that Belarus has no intention of returning fresh HEU to Russia. Similarly, according to DOE officials, a facility in Ukraine hopes to build a new research reactor that would be fueled by its inventory of Russian-origin HEU. If the facility decides not to return its HEU to Russia, DOE would try to work with the facility to downblend it into LEU.

Another factor that affects DOE's schedule for the Russian fuel return program is the development of new LEU fuels to replace HEU in research reactors that cannot convert to currently available LEU fuels. In our July 2004 report on the RERTR program, we identified several research reactors that use Russian-origin HEU fuel that cannot currently convert to LEU. For example, a research reactor in Poland is waiting for the development of a new LEU fuel before it can convert. However, the projected completion of a replacement LEU fuel has been delayed from 2006 until 2010 as a result of technical setbacks in the development process. DOE officials said that rather than try to return the fresh HEU fuel from these reactors to Russia before a replacement LEU fuel is available, the Russian fuel return program would return the HEU as spent fuel, after it is used up in the reactors. Consequently, although DOE officials have said they plan to return all fresh HEU to Russia by 2005, some Russian-supplied research reactors that cannot convert to currently available LEU fuels could continue to store fresh HEU fuel after that date. (DOE has identified 4 countries for removal of fresh HEU by 2005—Belarus, Kazakhstan, Ukraine, and Uzbekistan.)

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## DOE Is Considering Ways to Accelerate the Return of HEU to Russia

DOE has developed proposals for accelerating the Russian fuel return program that could increase the cost of the program by over \$30 million. DOE would like to complete the program by 2009, 4 years sooner than its original time frame of 2013. According to DOE officials, one possibility is to purchase casks that could be used to transport spent HEU fuel by air

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rather than by train and would also be able to hold more fuel, requiring fewer shipments. While the shipments of fresh HEU fuel to date have all been by air, currently DOE and Russia do not have access to casks that are qualified according to IAEA standards for shipment of spent fuel by air. Without the high-capacity casks, DOE must transport spent fuel by train. DOE estimates that the high-capacity casks would require a one-time expenditure of \$5.5 million.

DOE officials also said they are considering a “mobile melt-and-dilute” system for transforming spent HEU fuel into blocks of LEU. The equipment for this system could be transported to reactors that possess spent HEU fuel and be used to blend down the HEU on site, without returning the fuel to Russia. DOE would use the system as a stopgap measure in response to potential delays in returning spent HEU fuel to Russia, alleviating security concerns at foreign research reactors with Russian-origin spent HEU. DOE officials said they anticipate that the LEU blocks could then be returned to Russia at a later date. Development of the system has begun at DOE’s Savannah River Site, but DOE has not yet decided whether to seek funding for this proposal.

DOE had hoped to facilitate the return of spent HEU fuel to Russia by using casks that are currently used to store Russian-origin spent HEU fuel in Germany. DOE officials said that, with Germany’s cooperation, the Russian fuel return program would first provide assistance for returning spent HEU fuel from Germany to Russia and then reuse the casks for shipments of spent HEU from other countries. However, the German government has not agreed to participate in the Russian fuel return program. In a December 2000 letter to IAEA, Germany cited a number of issues that would require clarification before it would agree to participate in the program, including how spent HEU fuel returned to Russia would be safeguarded and disposed of. Officials at the site in Germany where the HEU is stored said they would be willing to participate in the Russian fuel return program and that returning the HEU would reduce the need for security at the facility. However, German government officials told us that Germany plans to dispose of its Russian-origin spent HEU fuel domestically and keep the casks for long-term storage of the fuel. One official said that concerns over Russia’s ability to secure the HEU played a role in Germany’s decision to not participate in the Russian fuel return program.

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## Conclusions

DOE’s efforts to recover U.S.-origin HEU for safe storage and disposal in the United States have resulted in the return of enough HEU to build more

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then 20 nuclear weapons. However, despite DOE's intention of accelerating the fuel acceptance program, there are still 11 countries that have not made plans to return all of their U.S.-origin HEU to the United States. Lack of funding for conversion to LEU is one of the reasons foreign research reactors continue to use HEU. Foreign research reactors that do not plan to convert to LEU generally also do not have plans to return HEU fuel to the United States. In our July 2004 report on DOE's RERTR program, we recommended that DOE evaluate the costs and benefits of providing incentives to foreign research reactors that use U.S.-origin HEU to convert to LEU. If DOE decides to provide such incentives, operators of some foreign reactors may decide to return their HEU fuel to the United States as well as convert to LEU. We encourage DOE to consider the increased likelihood of recovering additional amounts of HEU as one of the benefits of providing additional incentives to foreign research reactors to convert to LEU. Similarly, lowering the fees for accepting HEU could encourage additional research reactors in high-income countries to return the nuclear material to the United States. These actions could support DOE's efforts to accelerate the fuel acceptance program.

When DOE implemented the fuel acceptance program in 1996, it reserved the right to adjust the fees to meet changing circumstances. Currently, one of the biggest potential changes in the program is DOE's proposed extension of the program to continue providing operators of research reactors that converted to LEU fuel with a means of disposing of spent fuel. While we support DOE efforts to assist foreign research reactors that have converted to LEU in accordance with U.S. nonproliferation objectives, the original intent of DOE's fuel acceptance program was not to indefinitely accept spent LEU fuel at below the full cost of disposal. DOE has not revised the fees that research reactors in high-income countries pay for returning their spent fuel to the United States since 1996. Continuing the current fee structure through the end of as much as a 10-year program extension would mean keeping the 1996 fees set at the same level for 23 years. While lowering the fees for returning HEU may encourage additional countries to participate in the fuel return program, re-evaluating the fees for accepting LEU fuel, taking into account DOE's proposed extension of the program, may show that DOE could raise the fees and recover a greater portion of the total disposal costs for accepting LEU from high-income countries. DOE may be able to raise the fees while still encouraging operators of foreign research reactors to convert to LEU fuel and without unduly penalizing foreign reactors that have already converted.

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DOE faces a complex set of issues for each shipment of HEU to Russia, such as environmental requirements in Russia and negotiations with the countries that are returning their HEU to provide them with incentives to participate in the program. While DOE would like to accelerate the return of HEU to Russia, these issues have the potential to cause delays. For DOE to complete the program as quickly and as efficiently as possible, the cooperation of Russia and countries that have Russian-origin HEU is essential. We support DOE's efforts to work with Russia to resolve issues that stand in the way of returning HEU as quickly as possible and to pursue options such as purchasing high-capacity casks that support DOE's objective of accelerating the Russian fuel return program.

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## Recommendations for Executive Action

We recommend that the Secretary of Energy and the Administrator of the National Nuclear Security Administration take the following two actions:

- consider offering incentives to foreign research reactors to return HEU to the United States, including lowering the fees that DOE charges for accepting HEU fuel from high-income countries; and
- evaluate raising the fees for accepting LEU fuel from research reactors in high-income countries to recover as much of the cost for disposing of the fuel in the United States as possible, if doing so would not adversely affect the conversion of reactors to LEU and the return of HEU or create unmanageable financial burdens for the reactors.

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## Agency Comments and Our Evaluation

We provided draft copies of this report to the Departments of Energy and State for their review and comment. In its written comments (presented as app. II), DOE concurred with our recommendations. State did not provide written comments. Both DOE and State provided technical comments, which we incorporated into the report as appropriate.

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## Scope and Methodology

To review the progress of DOE's fuel acceptance program, we analyzed program documentation including DOE's February 1996 *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*, the May 1996 Record of Decision establishing the program, and the DOE IG's February 2004 audit report on the program. In addition, we analyzed documents outlining the structure of fees DOE imposes on research reactors in high-income countries for returning HEU and LEU

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fuel to the United States and how the fees were derived. We analyzed data from DOE on the amount of HEU and LEU fuel returned to the United States, the plans of countries that still have U.S.-origin HEU for participating in the program, and the amount of fees paid by research reactors in high-income countries. We also interviewed key officials at DOE; the State Department; the DOE facilities in South Carolina and Idaho where HEU and LEU fuel from foreign research reactors is being placed in interim storage; and DOE's Argonne National Laboratory, which has expertise on the amount and type of U.S.-origin HEU and LEU at foreign research reactors.

We visited five countries that have U.S.-origin HEU—Belgium, Germany, the Netherlands, Portugal, and Romania. We selected a nonprobability sample of countries based on a number of criteria. In particular, we selected three countries that have returned HEU to the United States under the fuel acceptance program (Germany, the Netherlands, and Romania) and two countries that have not returned HEU to the United States (Belgium and Portugal). In addition, we selected three high-income countries (Belgium, Germany, and the Netherlands), one non-high-income country (Romania), and one country that transitioned into a high-income country (Portugal). During our site visits, we met with research reactor operators and government officials responsible for regulating the research reactors and the disposal of spent research reactor fuel. We asked a standard set of questions concerning reasons for participating or not participating in DOE's fuel acceptance program, plans for participating in the future, options for disposing of spent fuel other than returning it to the United States, and the potential extension of the fuel acceptance program beyond 2009. In addition to visiting five countries with U.S.-origin HEU, we interviewed representatives of the Australian, Jamaican, and Swedish research reactor operators and the group of research reactors that petitioned DOE to extend the fuel acceptance program beyond 2009.

We assessed the reliability of data obtained from DOE on the amount of HEU and LEU fuel returned to the United States and the amount of fees paid by research reactors in high-income countries. In particular, officials at the DOE facilities in South Carolina and Idaho where the fuel is stored provided responses to a standard set of data reliability questions covering issues such as data entry, access, and quality control procedures. We asked follow-up questions whenever necessary. We also performed a series of checks on the data to ensure that it was complete and accurate. We found several errors in the data that we brought to the attention of DOE officials, who then reviewed the data and provided corrections. Based on our assessment, we determined that the data provided by DOE

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was sufficiently reliable for our purposes. We converted dollar amounts of DOE expenditures for the fuel acceptance program and fees received from research reactors in high-income countries into constant fiscal year 2004 dollars.

To review the progress of DOE's Russian fuel return program, we analyzed program documentation on the amounts and locations of Russian-origin HEU at foreign research reactors; reports on DOE fact-finding missions to research reactors in seven countries included in the Russian fuel return program; DOE's agreements with Russia and Uzbekistan on the program; and letters between the IAEA and countries with Russian-origin HEU on their potential participation in the program. In addition, DOE provided documentation on shipments of fresh HEU it has supported to date. We discussed the program with key DOE and State Department officials. We also traveled to Russia to discuss the program with Russian officials responsible for implementing the program with DOE and reviewing the environmental assessment for returning spent HEU fuel.

We visited four countries that have Russian-origin HEU—Germany, Poland, Romania, and Ukraine. We selected a nonprobability sample of countries based on a number of criteria. In particular, we selected one country that had returned HEU to Russia under the Russian fuel return program (Romania) and three that had not returned HEU. In addition, we selected the two countries that are eligible to participate in both the U.S. fuel acceptance program and the Russian fuel return program (Germany and Romania). During our site visits, we met with research reactor operators and government officials responsible for regulating the research reactors and the disposal of spent research reactor fuel. We asked a standard set of questions concerning reasons for participating or not participating in the Russian fuel return program, plans for participating in the future, and options for disposing of spent fuel other than returning it to Russia.

As part of our review of both programs, we also analyzed NNSA's 2004 Global Research and Test Reactor Security Initiative Report and attended an annual international conference organized by DOE's RERTR program. For technical expertise, we relied on GAO's Chief Technologist, who participated in meetings with officials at Argonne National Laboratory.


We conducted our work from July 2003 to October 2004 in accordance with generally accepted government auditing standards.

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We are sending copies of this report to the Secretary of Energy; the Administrator, National Nuclear Security Administration; the Secretary of State; the Chairman, NRC; the Secretary of Homeland Security; the Director, Office of Management and Budget; and interested congressional committees. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please call me at (202) 512-3841. Key contributors to this report include Joseph Cook, Jonathan McMurray, Mehrzad Nadji, Kirstin B.L. Nelson, Judy Pagano, Peter Ruedel, F. James Shafer Jr., and Keith Rhodes, GAO's Chief Technologist.

Sincerely yours,

A handwritten signature in black ink that reads "Gene Aloise". The signature is written in a cursive style with a large, looped initial "G".

Gene Aloise  
Acting Director, Natural  
Resources and Environment

# Appendix I: Details of HEU and LEU Fuel Returned to the United States

**Table 3: HEU and LEU Fuel Returned to the United States, by Country, and Fees Paid by Research Reactor Operators in High-Income Countries**

Country	HEU (kilograms)	LEU (kilograms)	Fees (millions)
Argentina	29		
Australia	34		\$2.2
Austria	3	71	1.3
Brazil	5	62	
Canada	11		1.6
Chile	8		
Colombia	3		
Denmark	6	309	5.7
Germany	102	301	21.9
Greece	5		
Indonesia		206	
Italy	23	47	5.3
Japan	537	298	36.9
Netherlands	21		2.6
Philippines	3	20	
Portugal		29	
Romania	6		
Slovenia	5	35	
South Korea	20	33	
Spain	4	12	0.9
Sweden	47	296	12.4
Switzerland	34	73	3.4
Taiwan	4	23	1.6
Thailand	4		
United Kingdom		17	1.5
Uruguay		16	
Venezuela		39	
<b>Total</b>	<b>914</b>	<b>1,887</b>	<b>\$97.3</b>

Source: DOE.

Notes: The amount of HEU returned, 914 kilograms, is based on the total uranium in the fuel after being used in a research reactor. It is equivalent to 1,159 kilograms of total uranium before being used in a reactor.

Dollars are in constant fiscal year 2004 dollars.



# Appendix II: Comments from the Department of Energy



Department of Energy  
National Nuclear Security Administration  
Washington, DC 20585



NOV 15 2004

Mr. Gene Aloise  
Acting Director, Natural  
Resources and Environment  
Government Accountability Office  
Washington, D.C. 20548

Dear Mr. Aloise:

The National Nuclear Security Administration (NNSA) appreciates the opportunity to have reviewed the Government Accountability Office (GAO) draft report, GAO-05-57, "NUCLEAR NONPROLIFERATION: DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia." We understand that this draft report is the result of a request from the Senate's Chairman, Subcommittee on Emerging Threats and Capabilities, Committee on Armed Services.

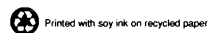
We appreciate the work that GAO performed and their apparent support of the programs' efforts. NNSA and the Office of Environmental Management concur with the report's recommendations that we should consider offering incentives to foreign research reactors to return HEU to the United States, including the evaluation of the possibility of modifying the existing policy regarding acceptance fees for material returned from high-income economy countries. NNSA will work with the Office of Environmental Management to determine how best to assess the fee policy given current program priorities.

Should you have any questions related to this response, please contact Richard Speidel, Director, Policy and Internal Controls Management. He may be contacted at 202-586-5009.

Sincerely,

Michael C. Kane  
Associate Administrator  
for Management and Administration

cc: Paul Longworth, Deputy Administrator  
for Defense Nuclear Nonproliferation  
Paul Golan, Acting Assistant Secretary  
for Environmental Management



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