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Report to the Chairman, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives

September 2009

# NUCLEAR NONPROLIFERATION

# National Nuclear Security Administration Has Improved the Security of Reactors in its Global Research Reactor Program, but Action Is Needed to Address Remaining Concerns


GAO-09-949

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Highlights

Highlights of GAO-09-949, a report to the Chairman, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives

### Why GAO Did This Study

Worldwide, about 165 research reactors use highly enriched uranium (HEU) fuel. Because HEU can also be used in nuclear weapons, the National Nuclear Security Administration (NNSA) established the Global Research Reactor Security (GRRS) program to make security upgrades at foreign research reactors whose security did not meet guidelines established by the International Atomic Energy Agency (IAEA). GAO was asked to assess (1) the status of NNSA's efforts to secure foreign research reactors, (2) the extent to which selected foreign research reactors with NNSA security upgrades meet IAEA's security guidelines, and (3) the extent to which NNSA coordinates the GRRS program with other countries and the IAEA. GAO reviewed NNSA and IAEA documents and visited five of the 22 research reactors in the GRRS program, which were selected on the basis of when upgrades had been completed and because the reactors still possess HEU.

### What GAO Recommends

GAO is making recommendations to help NNSA improve security procedures and encourage the development of national security laws and regulations in countries with HEU-fueled research reactors.

In commenting on this report, NNSA agreed with the findings and outlined the actions that it plans to take to address the report's recommendations.

View GAO-09-949 or key components.
For more information, contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

### What GAO Found

As of August 2009, NNSA reports that it had upgraded the security at 18 of the 22 foreign research reactors in the GRRS program at a total cost of approximately $8 million. NNSA plans to complete physical security upgrades at the remaining reactors by 2010 at an additional cost of $6 million. Security upgrades that GAO observed during its site visits include heavily reinforced vaults to store HEU fuel, motion detector sensors and security cameras to detect unauthorized access, and fortified central alarm stations that allow on-site guards the ability to monitor alarms and security cameras and communicate with response forces.

Foreign research reactors that have received NNSA upgrades where GAO conducted site visits generally meet IAEA security guidelines; however, in some cases, critical security weaknesses remain. At four of the five reactors visited, GAO identified security conditions that did not meet IAEA guidelines. For example, (1) at two reactors, no emergency response exercises had been conducted between the on-site guard force and off-site emergency response force, and one of these reactors lacked any formal response plans for emergencies involving attempts to steal HEU fuel; and (2) personnel at one research reactor did not search visitors or their belongings before granting them access to restricted areas where nuclear material is present. Furthermore, the government agency charged with regulating the operation of one research reactor has neither developed safety and security regulations nor has the country enacted laws ensuring the safe and secure operation of nuclear facilities. NNSA and Sandia National Laboratories officials responsible for making security upgrades at these reactors acknowledged that these continued vulnerabilities potentially compromise security at these reactors. Although the officials stressed the importance of NNSA continuing to work with these countries, there are no specific plans to do so after security upgrades at the remaining reactors are completed in 2010.

NNSA officials coordinate with foreign government research reactor operators to design, install, and sustain security upgrades. Because the GRRS program is a voluntary and cooperative program, in some cases, NNSA faces challenges obtaining foreign governments' commitment to complete security upgrades in a timely manner. For example, progress to secure a research reactor in one country GAO visited has been delayed by as many as 4 years due to foreign government reluctance in accepting NNSA assistance and delays approving the designed security upgrades. Recently, NNSA has begun working with IAEA's Office of Nuclear Security to establish a sustainability program to help ensure the continued effectiveness of NNSA-funded security upgrades and to help research reactor operators implement security procedures. IAEA plans to conduct pilot programs at three research reactors in 2009 and then expand the program. NNSA will continue to support sustainability efforts through the IAEA after the completion of security upgrades at the remaining reactors in 2010.

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## Abbreviations

| | |
|---|---|
| DBT | Design Basis Threat |
| DOE | Department of Energy |
| GRRS | Global Research Reactor Security |
| GTRI | Global Threat Reduction Initiative |
| HEU | highly enriched uranium |
| IAEA | International Atomic Energy Agency |
| LEU | low enriched uranium |
| NNSA | National Nuclear Security Administration |
| NRC | U.S. Nuclear Regulatory Commission |

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**United States Government Accountability Office**
**Washington, DC 20548**

September 17, 2009

The Honorable John F. Tierney
Chairman
Subcommittee on National Security
and Foreign Affairs
Committee on Oversight
and Government Reform
House of Representatives

Dear Mr. Chairman:

Nuclear research reactors are used for research, training, and development in many scientific fields, including nuclear engineering, physics, and medicine. According to the National Nuclear Security Administration (NNSA), a separately organized agency within the Department of Energy (DOE),[1] there are about 165 operating research reactors worldwide that use highly enriched uranium (HEU) as fuel.[2] Concerns exist that terrorists may target research reactors to steal HEU fuel for use in a nuclear bomb. As little as 25 kilograms of HEU are needed to construct a nuclear bomb. According to the 2007 National Intelligence Estimate on the Terrorist Threat to U.S. Homeland Security, al-Qaeda continues to seek materials for nuclear and radiological weapons and would not hesitate to use them. Furthermore, the International Atomic Energy Agency (IAEA), which provides guidelines for the safety and physical security of civilian nuclear reactors including research reactors, has determined that the threat of nuclear terrorism remains undiminished and has concluded that the consequences of a malicious act involving a nuclear explosive device would be catastrophic.[3] In a January 2009

[1]NNSA was created by the National Defense Authorization Act for Fiscal Year 2000, Pub. L. No. 106-65 (1999), with responsibility for the nation's nuclear weapons, nonproliferation, and naval reactors programs.

[2]HEU, which can be used in nuclear weapons, is uranium enriched in the isotope uranium-235 to 20 percent or greater. In contrast, low enriched uranium, contains less than 20 percent uranium-235.

[3]IAEA, an autonomous international organization affiliated with the United Nations, was established in Vienna, Austria, in 1957. The agency has the dual role of promoting the peaceful uses of nuclear energy by transferring nuclear safety and technical cooperation programs, and verifying, through its safeguards program, that nuclear materials subject to safeguards are not diverted to nuclear weapons or other proscribed purposes.

strategic plan for reducing nuclear and radiological threats worldwide, NNSA stated that President Obama has identified preventing terrorists from acquiring nuclear or radiological weapons as the number one national security priority of his administration.[4]

Starting in 1953, through the Atoms for Peace program, the United States supplied research reactors and the fuel needed to operate them to many countries around the world. Similarly, the Soviet Union also assisted several nations in building research reactors and also supplied them with fuel. Nuclear technology was provided to these foreign counties in exchange for a commitment not to develop nuclear weapons. Initially, the research reactors supplied by the Atoms for Peace program used low enriched uranium (LEU) fuel, which cannot be used in a nuclear bomb, but many reactors were gradually switched from LEU to HEU fuel. At the time many of these reactors were built, or subsequently converted to use HEU, LEU fuels were not capable of producing many of the desired conditions in research reactors. HEU fuel lasted longer and was less expensive over time than LEU fuel because the reactors did not need to be refueled as often. Because of concerns about the threats posed by the potential theft or diversion of HEU for use in a nuclear bomb, new, more effective LEU fuels have been and are being developed, which would allow research reactors to convert from HEU to LEU fuel.

The purpose of DOE's Global Threat Reduction Initiative (GTRI) is to protect vulnerable nuclear and radiological material at civilian sites worldwide, including research reactors. Administered by NNSA, GTRI has three goals: (1) to convert research reactors and isotope production facilities from using HEU to using LEU, (2) to remove and dispose of excess nuclear and radiological materials, and (3) to protect high-priority nuclear and radiological materials from theft and sabotage. We reported on DOE's progress in achieving the first two goals in 2004.[5]

NNSA seeks to achieve GTRI's third goal at research reactors worldwide through its Global Research Reactor Security (GRRS) program, which is a

[4]NNSA, *Global Threat Reduction Initiative Strategic Plan: Reducing Nuclear and Radiological Threats Worldwide* (Washington, D.C., Jan. 22, 2009).

[5]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); and GAO, *Nuclear Nonproliferation: DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia*, GAO-05-57 (Washington, D.C.: Nov. 19, 2004).

voluntary and cooperative program that depends on countries accepting NNSA assistance to make security improvements. The GRRS program assesses security, designs security systems, and provides funding for security upgrades in order to protect vulnerable nuclear material at research reactors. These upgrades are needed to secure HEU fuel until permanent threat reduction solutions can be achieved, such as converting the reactors to LEU fuel and removing the HEU fuel.

Each nation that possesses a research reactor is responsible for the security of its own research reactors. Since 1972, IAEA has provided its member states with guidelines for the physical protection of nuclear material, most recently in 1999.[6] These guidelines contain administrative and technical measures designed to prevent the sabotage of nuclear facilities and the theft or other unauthorized diversions of nuclear material. According to IAEA's guidelines, a comprehensive physical protection system to secure nuclear material should include, among other things,

- technical measures such as vaults, perimeter barriers, intrusion sensors, and alarms;
- material control procedures; and
- adequately equipped and appropriately trained guard and emergency response forces.

According to IAEA's guidelines, member states should ensure that their national laws ensure the proper implementation of physical protection and verify continued compliance with physical protection regulations.

Although these IAEA guidelines are not binding on IAEA member states, the U.S. Nuclear Regulatory Commission (NRC) reviews applications for the export of nuclear material, including HEU fuel to foreign research reactors, to ensure that the recipient country's physical security measures are at least comparable to IAEA guidelines for the physical protection of nuclear material and nuclear facilities. In addition, NNSA has adopted the IAEA guidelines as a tool to help it determine what security upgrades are necessary at research reactors in the GRRS program. Using IAEA's

[6]IAEA, *Physical Protection of Nuclear Material and Nuclear Facilities*, *INFCIRC 225 Rev. 4.*, (1999).

guidelines, NNSA has developed a GTRI Design Basis Threat (DBT)—an analysis of the number of adversaries that security forces may face and how the adversaries may be equipped—that the GRRS program uses to develop security upgrades at research reactors. Security upgrades are designed to assist guard forces at research reactors to implement an "alert and notify" strategy, which relies on off-site response forces to supplement on-site forces to contain, locate, and neutralize adversaries before they can successfully sabotage the reactor or steal nuclear material. The alert and notify strategy is not as stringent as the costly "denial" strategy, which is used primarily in settings where nuclear weapons or significant nuclear components are present. With a denial strategy, the security system and on-site guard forces must detect, delay, respond to, and defeat adversaries before they gain access to nuclear weapons or components.

In January 2008, we reported on the security of research reactors in the United States that are regulated by NRC.[7] In response to your request, this report focuses on NNSA's efforts to improve security of research reactors worldwide. Specifically, we examined (1) the status of NNSA's efforts to secure foreign research reactors, (2) the extent to which selected research reactors with NNSA security upgrades meet IAEA's security guidelines, and (3) the extent to which NNSA coordinates its GRRS program with other countries and the IAEA.

## Scope and Methodology

To address our objectives, we reviewed relevant NNSA and IAEA policy, guidelines, and planning documents. For NNSA, we examined its Protection and Sustainability Criteria Document, which describes the DBT—the baseline threat for which security measures should be developed at research reactors in the GRRS program. In addition, we reviewed NNSA's strategic plans for the GRRS program and work schedules for conducting and completing security work activities. We also met with NNSA officials responsible for implementing the GRRS program and with Sandia National Laboratories (Sandia) technical experts who provide assistance to NNSA in implementing the program. We also met with IAEA officials from IAEA's Office of Nuclear Security, Division of Nuclear Fuel Cycle and Waste Technology, and IAEA's Department of Safeguards.

[7]GAO, *Nuclear Security: Action May Be Needed to Reassess the Security of NRC-Licensed Research Reactors*, GAO-08-403 (Washington, D.C.: Jan. 31, 2008).

We reviewed security upgrades at a nonprobability sample of five research reactors in five different countries—Czech Republic, Hungary, Mexico, Romania, and Serbia. This sample cannot be used to generalize findings from these countries to all countries in the program. We selected these reactors based upon whether the reactors still use or store HEU fuel and when NNSA had completed physical protection upgrades. Four of the five reactors had already received security upgrades, while work was ongoing at the fifth reactor. In the course of our work, we visited each of these five reactors to tour the facilities and inspect security upgrades that had been made or were in process. During our visits, we interviewed officials managing the reactors, on-site security officials, police, and other law enforcement officials responsible for responding to security incidents, as well as government officials responsible for regulating security at these reactors. At each of these reactors, we conducted interviews with a standard set of questions concerning the physical protection of the facility, the security upgrades that were being made, and the extent of the facility's coordination with NNSA and IAEA. We also compared the security systems at the facilities with IAEA guidelines—particularly INFCIRC 225, Rev. 4, *Physical Protection of Nuclear Material and Nuclear Facilities*. We also reviewed NNSA documents about each reactor, including reactor visit reports and vulnerability assessments.

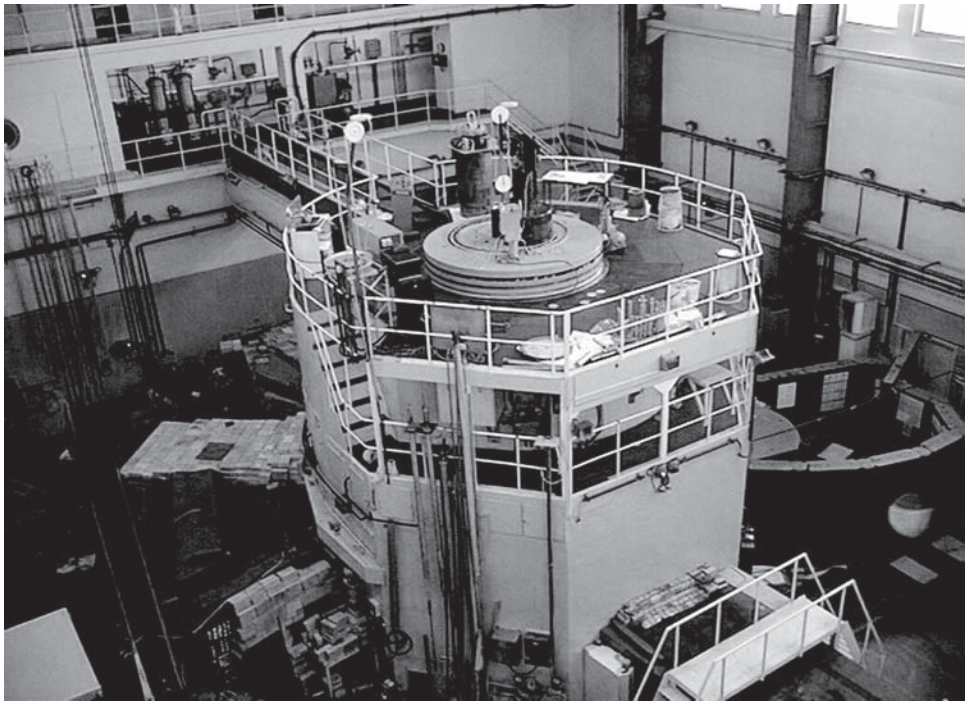
We conducted this performance audit from August 2008 to September 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions 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

Research reactors are generally smaller than nuclear power reactors, ranging in size from less than 1 megawatt to as high as 250 megawatts, compared with the 3,000 megawatts found for a typical commercial nuclear power reactor. In addition, unlike power reactors, many research reactors use HEU fuel instead of LEU. Although some research reactors have shut down or converted to LEU fuel and returned their HEU fuel to the United States or Russia, about 165 research reactors throughout the world continue to use HEU. NNSA efforts to convert reactors from HEU to LEU fuel use and return HEU fuel to the United States and Russia has led to the conversion of 57 reactors, the shutdown of 7 reactors, the return of HEU from 59 reactors, and the elimination of all HEU from 46 reactor facilities. NNSA plans to continue converting reactors and returning HEU

fuel to its country of origin. However, because it will take several years to convert reactors to LEU fuel use and return the HEU fuel, in the interim security needs to be ensured at these reactors. Figure 1 shows the interior of a research reactor in an Eastern European country that still uses Russian supplied HEU.

**Figure 1: Interior of a Soviet-Built HEU Research Reactor**



Source: Reactor Operator.

As NNSA and its predecessor agencies recognized the threat posed by the theft or diversion of nuclear materials—including HEU research reactor fuel—for nuclear weapons' purposes, it initiated a number of efforts to address this threat. First, since 1974, DOE has supported a program to determine whether nuclear material provided by the United States to other countries for peaceful purposes is adequately protected. Managed by NNSA's Division of Nonproliferation and International Security, this program prioritizes and selects facilities for physical protection assessment visits, leads such visits to determine if the facility meets IAEA guidelines for security, and, in the cases where the visited facility does not meet IAEA guidelines, makes recommendations to improve security. However, unlike the GRRS program, NNSA's Office of Nonproliferation and International Security does not fund or install security upgrades at

research reactors overseas. Second, after the collapse of the Soviet Union, DOE established the Material Protection, Control, and Accounting program in 1995 to install improved security systems for nuclear material at civilian nuclear sites (including research reactors), naval fuel sites, and nuclear weapons laboratory sites in Russia and nations in the former Soviet Union. Third, prior to the establishment of NNSA, DOE established the GRRS program in 1993 to improve the security of research reactors that are in countries that NNSA considers in need of assistance, as well as research reactors in countries that are not included in other DOE/NNSA programs. As shown in Table 1, the GRRS program has identified 22 research reactors in 16 different countries in need of assistance that are not included in other DOE/NNSA programs. Originally managed by NNSA's Office of Nonproliferation and International Security, the GRRS program was transferred to the GTRI in 2005. The GRRS program is also beginning to provide security enhancements at research reactors located at universities in the United States, as requested by the Department of Homeland Security and the NRC. NNSA officials told us that they believe the decision to assist in upgrading the security of these reactors was based partly on our January 2008 report, which found potential security weaknesses at domestic research reactors regulated by NRC.[8]

**Table 1: Foreign Research Reactors in the GRRS Program**

| Country | Reactor | Fuel material |
|---|---|---|
| Chile | RECH-1, La Reina | HEU |
| Chile | RECH-2, Lo Aquirre | HEU |
| Czech Republic | LVR-15, NRIRez | HEU |
| Greece | GRR-1, Demokritos | HEU |
| Hungary | BRR | HEU |
| Indonesia | RSG-GAS, Serpong | HEU |
| Indonesia | TRIGA II, Bandung | LEU |
| Indonesia | Kartini P3TM, Yogyakarta | LEU |
| Jamaica | Slowpoke UWI CNS | HEU |
| Libya | IRT-1 and IRT-1 CA, Tajoura | HEU |
| Mexico | TRIGA MK-III (ININ), Salazar | HEU |
| Peru | RP-0 | LEU |
| Peru | RP-10l | LEU |

[8]GAO-08-403.

| Country | Reactor | Fuel material |
|---|---|---|
| Poland | Maria, Swierk | HEU |
| Poland | ZUOP (Eva spent fuel), Swierk | HEU |
| Portugal | RPI | HEU |
| Romania | TRIGA II, Pitesti | HEU |
| Romania | VVR-s, Magurele | HEU |
| Serbia | Vinca | HEU |
| South Africa | SAFARI-1, Pelindaba | HEU |
| Turkey | TR-2 Cekmece | HEU |
| Vietnam | TRIGA Mark II, Dalat | HEU |

Source: NNSA.

Notes: (1) Two reactors in Indonesia and two reactors in Peru that use LEU fuel—which cannot be used to make a nuclear bomb but are potential targets of sabotage to release radioactivity into the area surrounding a reactor—have received security upgrades because of high levels of terrorist activities in regions where the reactors are located or because of their proximity to U.S. installations.

(2) Subsequent to the installation of security upgrades by the GRRS program, NNSA has converted and removed all HEU from 4 reactors—GRR-1 in Greece, RPI in Portugal, Pitesti in Romania, and Magurele in Romania.

## NNSA Has Improved the Security of Research Reactors and Plans to Continue Upgrading the Security of Additional Reactors

As of August 2009, NNSA reports that it had upgraded the security at 18 of the 22 foreign research reactors in the GRRS program at a total cost of approximately $8 million. NNSA plans to complete upgrades or remove all HEU prior to making upgrades at the remaining 4 reactors and to make further upgrades at some reactors where initial upgrades have already been made, spending an additional $6 million before ending physical security upgrades in 2010. For example, at one research reactor we visited, NNSA has already spent $760,000 on security upgrades and plans to spend $650,000 to pay for additional security upgrades, which will enable the facility to meet IAEA guidelines for security. NNSA also plans to spend an additional $378,000 for maintenance and sustainability of the security system at this facility over the next several years. NNSA is planning to complete all physical protection upgrades at GRRS reactors by the end of 2010.

NNSA prioritizes its schedule for upgrading the security of research reactors depending on the amount and type of nuclear or radioactive material at the reactor and other threat factors, such as the vulnerability condition of sites, country-level threat, and proximity to strategic assets. To make security upgrades, NNSA works with Sandia security experts to assess security needs at reactor facilities, design security upgrades and systems, assists foreign reactor operators in making improvements, and review security upgrades once they have been made. With NNSA approval,

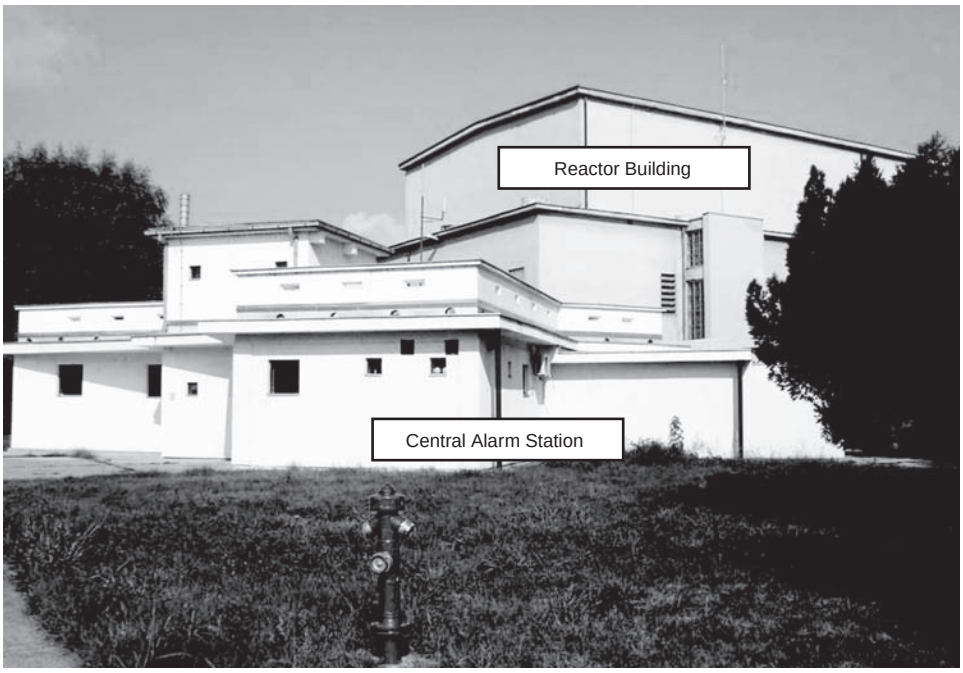
Sandia works with local firms specializing in installing security systems to make security upgrades. Security upgrades we observed during our visits to reactors in the GRRS program included, among other things,

- construction of new, heavily reinforced vaults to store HEU fuel;
- installation of motion detector sensors and security cameras to detect unauthorized entry into reactor buildings and provide the ability to remotely monitor activities in those buildings;
- replacement of glass entry doors with hardened steel doors equipped with magnetic locks and controlled by card readers or keypads; and
- upgrades or construction of new fortified central alarm stations that allow on-site guards to monitor alarms and security cameras, and communicate with response forces.[9]

Figure 2 shows a newly built fortified central alarm station at a HEU research reactor. Figure 3 shows the upgraded alarm display and closed circuit television monitors inside a central alarm station at another HEU reactor.

[9]The purpose of the central alarm station is to monitor the employees, general public, and environment of the entire reactor complex. In addition, the central alarm station serves as a single, central contact during emergency situations.

**Figure 2: Newly Built Fortified Central Alarm Station at a HEU Research Reactor**




Source: NNSA.

**Figure 3: Upgraded Alarm Display and Closed Circuit Television Monitors Inside a Central Alarm Station at a HEU Research Reactor**

Source: NNSA.

In addition, NNSA works with officials in countries included in the GRRS program to develop emergency plans and training exercises with on-site guard forces as well as local, regional, and national law enforcement agencies. For example, at one facility we visited, NNSA officials had worked with the reactor managers to develop emergency plans, and the managers routinely test these plans with different elements of the national emergency responders including the facility guard force, local police, regional police, and the national–level law enforcement including special assault teams. IAEA guidelines state that coordination between facility guards and off-site response forces should be regularly exercised. In addition, NNSA's alert and notify strategy relies on off-site response forces to supplement the on-site guard force to contain, locate, and neutralize adversaries before they can successfully steal nuclear material or sabotage the reactor.

The focus of NNSA's program has been on protecting reactors that use or store HEU fuel that could potentially be used in an improvised nuclear device where security does not meet IAEA guidelines. In addition, some research reactors using LEU fuel—which cannot be used to make a

nuclear bomb but are potential targets of sabotage to release radioactivity into the area surrounding a reactor—have received security upgrades because of high levels of terrorist activities in regions where the reactors are located or because of their proximity to U.S. installations.

## Although Reactors We Visited Generally Met IAEA Guidelines, Some Security Weaknesses Remain That Could Undermine NNSA-Funded Upgrades

The foreign research reactors we visited that have received NNSA assistance generally met IAEA physical protection guidelines; however, in some cases, critical security weaknesses remained. The focus of the GRRS program is to make physical security upgrades in accordance with IAEA guidelines. For example, IAEA guidelines recommend that nuclear facilities possessing the highest-risk nuclear materials have intrusion detection equipment and that all intrusion sensors and alarms should be monitored in a central alarm station that is staffed continuously to initiate appropriate responses to alarms. At all four of the research reactors we visited where NNSA upgrades have been completed, NNSA installed intrusion detection sensors on all entrances and infrared motion detectors in areas where nuclear material is stored to detect unauthorized access. In addition, at these reactors NNSA provided assistance to construct fortified central alarm stations that are staffed continuously by on-site security personnel to monitor alarms triggered by these sensors. NNSA is in the process of providing these same upgrades at the fifth reactor we visited. Despite these upgrades, the GRRS program has not focused on whether security planning, procedures, and regulations meet IAEA guidelines at international research reactors. In contrast, in the United States, the GRRS program has assisted research reactors to ensure that security planning, procedures, and regulations meet IAEA guidelines. For example, to meet IAEA's guidelines that emergency plans be regularly exercised, the program has provided emergency first responders with training and conducted table top exercises simulating emergency conditions. At four of the five reactors that we visited, we identified the following potential vulnerabilities that can undermine NNSA-funded upgrades. Specifically,

- IAEA security guidelines state that coordination between on-site guards and off-site response forces should be regularly exercised. At two reactors, however, no emergency response exercises had been conducted between the on-site guard force and off-site response forces, such as the national police, potentially limiting the effectiveness of these forces in an actual emergency. In addition, one of these reactors lacked any formal plans for emergencies involving attempts to steal HEU fuel or to sabotage reactors.

- IAEA security guidelines state that all persons entering or leaving reactor inner areas should be subject to a search to prevent the unauthorized

removal of nuclear material. However, personnel at one research reactor we visited did not search visitors or their belongings before granting them access to restricted areas where nuclear material is present, thereby potentially compromising the security upgrades made through NNSA assistance.

- IAEA security guidelines also state that all vehicles entering or leaving the protected areas should be subject to search. However, at another reactor that we visited personnel did not search vehicles that were allowed onto the site or vehicles exiting the site for potentially stolen nuclear material or other contraband.

- IAEA security guidelines state that the ceilings, walls, and floors of areas containing vulnerable nuclear material should be constructed to delay potential adversaries from accessing the material. However, at one facility, we discovered that protective covers over storage pools that contain HEU were not being used. These covers, which typically weigh hundreds of kilograms and must be moved using a crane, provide important protection for stored HEU by significantly increasing the time required for a potential adversary to access nuclear material. Although NNSA officials told us that these covers are not part of the security system, the covers would delay potential adversaries from accessing the HEU stored in the pool. Furthermore, the four entrance doors to another research reactor—which still had HEU fuel at the time that we visited, but has subsequently returned its HEU fuel—were not upgraded and provided only limited access delay. These doors were made of wood that is only approximately 1 inch thick. In addition, the locks on these doors are not designed to prevent a determined attempt to access the research reactor facility. Officials at this facility told us that they had requested NNSA funding to replace the doors with hardened steel doors. However, NNSA did not agree to pay for hardened steel doors because it decided that the HEU fuel was sufficiently secured in a storage pool with heavy concrete covers.

- NNSA program guidance states that establishing and maintaining a reliable nuclear material inventory and tracking system are important elements for ensuring adequate security for these materials. However, at one reactor we learned that the operators of the reactor did not have an effective system of nuclear material control and accounting for the HEU fuel. For example, the operators of this reactor neither performed routine inventory checks on HEU fuel, nor had an exact accounting of the spent HEU fuel stored at the facility. In this case, NNSA officials told us that a lack of effective nuclear material accounting at this facility is due to the poor condition of the reactor fuel storage pool, which is contaminated with cesium that has leaked from fuel. These officials told us that an inventory will be

conducted as HEU fuel is prepared for shipment back to its country of origin.

- IAEA security guidelines state that unescorted access to protected areas should be limited to those persons whose trustworthiness has been determined. However, at another reactor we visited, background checks were not conducted on personnel with access to areas where nuclear materials are present.

- At the same reactor, according to foreign government officials, the government agency charged with regulating the operation of the research reactor had neither developed safety and security regulations, nor had the country enacted laws ensuring the safe and secure operation of nuclear facilities—including licensing, inspections, and emergency exercise procedures—as called for by IAEA guidelines.

NNSA and Sandia officials responsible for making security upgrades at these reactors acknowledged that, even with NNSA-funded upgrades, these continued vulnerabilities potentially compromise security. These officials stressed the importance of NNSA continuing to work with these countries to ensure that research reactors have effective and comprehensive physical protection systems and procedures consistent with IAEA guidelines. Furthermore, they expressed the need to eventually convert these reactors to LEU and return the HEU fuel to its country of origin, as well as to develop national laws and regulations to ensure the safe and secure operation of nuclear facilities. In addition, Sandia officials commented that there is no substitute for NNSA and Sandia visits to reactors that have received physical security upgrades to determine whether the upgrades have been installed, function as designed, and are properly maintained. However, these visits generally have not been used to assist the facilities in developing security policy and procedures that comply with IAEA security guidelines, and there are no specific plans to continue these visits after security upgrades at the remaining reactors are completed in 2010.

## NNSA Coordinates Security Upgrades with Other Countries and IAEA, but Additional Cooperation is Needed to Implement Security Procedures Provided for in IAEA Guidelines

NNSA coordinates with research reactor operators to design, install, and sustain security upgrades. However, because the GRRS program is voluntary, NNSA faces challenges in obtaining consistent and timely cooperation from other countries to address remaining security weaknesses. With regard to IAEA, NNSA coordinates with the agency to identify research reactors that are in need of security upgrades and assistance. In addition, NNSA and IAEA have begun coordinating on a sustainability project to help ensure that research reactor operators adequately maintain NNSA funded upgrades by assisting in the development of equipment testing and maintenance procedures and the development of emergency response plans.

### NNSA Coordinates with Other Countries to Implement Upgrades but Faces Challenges in Addressing Security Weaknesses at Some Research Reactors

NNSA officials and the physical security experts at Sandia coordinate with foreign government research reactor operators to design, install, and sustain physical security upgrades. To design security systems, NNSA and Sandia officials assess a research reactor's current security condition to identify security weaknesses and verify the amount, type, and location of nuclear material at the facility. The officials then work with foreign research reactor operators to design upgrades and use either the DBT established by the foreign government or a DBT developed by NNSA if the country has not developed its own DBT for nuclear facilities. Security upgrades are generally focused on the electronic elements of the security system used to detect unauthorized access and alert response forces, as well as access delay features such as hardened steel doors and storage vaults, instead of on the development of security policies and procedures provided for in IAEA guidelines.

Sandia officials also work with foreign government research reactor operators by overseeing the installation of security upgrades. In general, Sandia works with a security company that is then responsible for procuring and installing the designed security upgrades. To help ensure that the security upgrades are being installed properly, Sandia requires the security company and the foreign research reactor operators to periodically submit status reports and equipment lists for Sandia's review. In some instances, countries will share the cost of installing the upgrades with NNSA. For example, the government of the Czech Republic provided $800,000 to upgrade the security at one of its research reactors. Once the security contractor completes the installation, NNSA and Sandia officials

and foreign government research reactor operators inspect the upgrades and determine if they were installed and are functioning as designed.

To help ensure that the upgrades are sustained, NNSA and Sandia officials periodically visit research reactors to review the condition of upgrades and to determine if supplemental upgrades are needed. According to NNSA and Sandia officials, these visits are crucial to maintaining a collaborative relationship with foreign research reactor operators to help ensure that security upgrades are sustained over the long term. As a result of recent security assessment visits, NNSA officials said that they are planning additional upgrades at three reactors we visited where security upgrades had already been completed. These additional upgrades are to include, among other things, new closed circuit television cameras, a device used to provide emergency electrical power, and replacement door locks; they do not include assistance in developing security policies and procedures provided for in IAEA guidelines. NNSA officials determined that supplemental upgrades at the fourth reactor were not needed because they planned to return the reactor's HEU to Russia in the summer of 2009, which was 7 months after the assessment was made.[10]

NNSA has also been purchasing warranty and maintenance contracts for recently installed upgrades and for certain reactors where upgrades are several years old and foreign government research reactor operators lack sufficient funding for maintenance activities. NNSA requires the countries or reactor operators who receive these warranty and maintenance contracts to provide written assurance that they will continue to sustain the upgrades at their own expense after the contract expires, although NNSA will consider providing additional coverage on a case-by-case basis. In addition, NNSA is working with IAEA and governments in each of the countries that received security upgrades at research reactors to develop a long-term sustainability plan for security systems.

Because the GRRS program is voluntary and cooperative, NNSA officials told us that in some cases they face challenges in obtaining foreign governments' commitment to complete security upgrades in a timely manner. For example, progress to secure a research reactor in one country we visited has been delayed by as many as 4 years for two reasons. First, the country was initially reluctant to accept NNSA assistance and took 2 years to decide whether to accept funding for security improvements.

[10]In June 2009, NNSA announced that all HEU from this reactor was returned to Russia.

Second, security upgrades were further delayed at this reactor because of the country's delay in approving the design of the security upgrades and authorizing contractors to work at the reactor site. As a result, a number of security weaknesses at this facility have not yet been addressed—some of which NNSA identified as early as 2002. According to NNSA officials, the agency has been working with the Department of State to overcome these obstacles.

NNSA officials also told us that they have experienced situations where a foreign government has refused its assistance to make security upgrades. Specifically, one country has refused NNSA's multiple offers to upgrade a research reactor facility during the past 9 years. NNSA officials said that they have continued to offer this assistance through both direct bilateral negotiations and through IAEA. However, this foreign government has yet to accept NNSA assistance, and NNSA has concerns that known security weaknesses have not been addressed. In addition, NNSA has experienced two situations where the foreign government would not accept security upgrade assistance until agreements were reached with the United States on other issues related to nuclear energy and security. For example, NNSA assistance at one research reactor was delayed until the United States ratified an agreement with the foreign government authorizing and setting the conditions for transfers of U.S. civil nuclear technology and material to that government.[11] These issues have been resolved with both foreign governments. Due to the terrorist threat level in the areas where these reactors are located, NNSA has decided to forgo making security upgrades because it would take too long to design and install new security systems. Instead, NNSA is planning to remove the HEU fuel that is at these two reactors and return it to its country of origin this year.

[11]Section 123 of the Atomic Energy Act of 1954 as amended (42 U.S.C § 2153) establishes the requirements for the United States to engage in civil nuclear cooperation agreements with foreign governments.

## NNSA Coordinates with the IAEA to Identify Research Reactors for the GRRS Program, and Further Cooperation Is Needed to Sustain Upgrades and Implement Security Procedures Provided for in IAEA Guidelines

NNSA coordinates with the IAEA to identify research reactors in need of security upgrades that could be included in the GRRS program. Fourteen of the 19 research reactors that received NNSA-funded security upgrades were previously reviewed by an IAEA team, which recommended security improvements. According to IAEA officials, if a nation is unable to make the recommended security improvements itself, IAEA will recommend that it seek assistance from the GRRS program. In addition, NNSA works with IAEA to ensure security upgrades are complementary when both organizations are providing assistance at the same research reactor. For example, at one reactor we visited, NNSA upgraded the reactor's central alarm station and installed new intrusion sensors and cameras. At the same facility, IAEA is planning to install an X-ray machine and metal detector at the reactor's entrance to monitor personnel and packages entering and leaving the facility. In addition, NNSA officials implementing efforts to secure research reactors interact regularly with IAEA officials by holding quarterly coordination meetings. Furthermore, NNSA makes an annual financial pledge of between $1.6 and $1.9 million to IAEA's Nuclear Security Fund, which supports IAEA's Office of Nuclear Security activities, such as security reviews of international research reactors and other nuclear facilities.

Further cooperation is needed to sustain NNSA-funded upgrades and implement security procedures provided for in IAEA guidelines. While NNSA is planning to complete all physical protection upgrades at GRRS reactors by the end of 2010, GRRS officials are still concerned about the continued effectiveness of upgrades and any shortcomings related to security procedures and planning. Consequently, NNSA has recently begun working with IAEA's Office of Nuclear Security to establish a sustainability program. The purpose of the sustainability program is to help ensure that NNSA-funded security upgrades are properly maintained and to help research reactor operators implement security procedures and planning. To date, NNSA has provided IAEA with $550,000 and paid for a security expert from Pacific Northwest National Laboratory to administer the sustainability program. Under the sustainability program, IAEA will help research reactor operators develop

- capabilities for properly maintaining and testing installed security equipment, which will help ensure the future effectiveness of NNSA-funded upgrades;
- capabilities to ensure that security procedures are designed, implemented, and followed by research reactor management and personnel; and

- emergency response plans and agreements and procedures with a robust dedicated off-site response force for assistance in responding to emergency situations at the research reactor.

In addition, the sustainability program is expected to help foreign governments strengthen their nuclear security laws and regulations, as well as the nuclear security inspection process and procedures. For example, IAEA plans to work with a country to ensure it has an appropriate nuclear regulatory agency with the legal basis, as well as inspection and enforcement capabilities, to establish and oversee security requirements at nuclear facilities. IAEA plans to conduct pilot projects of the sustainability program at three research reactors in 2009, evaluate the results of the pilot projects, and then potentially expand the program in 2010 to all reactors in the GRRS program that still possess HEU. NNSA will continue to support sustainability efforts through the IAEA after the completion of security upgrades at the remaining reactors in 2010.

## Conclusions

Nuclear research reactors throughout the world continue to play an important role in research, education, science, and medicine. However, as long as some of these reactors continue to use HEU fuel or have HEU fuel stored on-site, they must be adequately protected from terrorists targeting them to steal the material or sabotage the reactors. NNSA's efforts to secure research reactors in the GRRS program have resulted in physical security upgrades such as heavily-reinforced vaults to store HEU fuel and new or improved alarms and intrusion detection sensors. However, security weaknesses remain at some research reactors in the GRRS program, many of which are the result of weaknesses in security procedures and emergency planning. NNSA's efforts have, to date, generally not included encouraging the development of effective security procedures or the development of laws and regulations ensuring the safe and secure operation of nuclear facilities.

NNSA has taken the first steps toward addressing these security deficiencies and is starting to work with IAEA to implement a comprehensive sustainability program to ensure that new security upgrades installed at these reactors undergo periodic maintenance and repair. These efforts must continue, even after NNSA completes installing physical security upgrades at the remaining reactors and ends the GRRS program in 2010. Because NNSA is working with foreign countries, it is also important that NNSA work cooperatively with these countries' governments and IAEA to develop rigorous policies and procedures governing security at these sites. Ultimately, the most effective security

improvement that can be made at these research reactors is to convert them to use LEU and to return all HEU fuel to the material's country of origin, thereby eliminating the reactors' attractiveness to terrorists seeking material to make an improvised nuclear device. We support the effort that NNSA is now taking to accelerate the schedule to convert reactors to LEU fuel use and return HEU fuel to its country of origin. The timely removal of this material from at-risk reactors will be, in the end, the most effective security improvement NNSA can make.

## Recommendations for Executive Action

To resolve remaining security weaknesses at foreign research reactors that use HEU fuel, we recommend that the Secretary of Energy direct the Administrator of NNSA to take the following three actions:

- While continuing to emphasize and accelerate NNSA efforts to convert reactors to LEU fuel use and return HEU fuel to its country of origin, we recommend that NNSA work with foreign government officials and research reactor operators in countries where security upgrades are in progress or have been completed to (1) take immediate action to address any remaining security weaknesses, including those that we identified in this report; and (2) ensure that security policies and procedures, including those for emergency response to security incidents, fully meet IAEA guidelines.

- In addition, in cooperation with IAEA's Office of Nuclear Safety, we recommend that NNSA work with foreign regulatory agencies to encourage the development, where needed, of national security laws and regulations to ensure the safe and secure operation of research reactors, including licensing, inspection, and emergency exercise procedures, as called for in IAEA guidelines.

## Agency Comments

We provided NNSA with a draft of this report for its review and comment. In its written comments, NNSA states that our report is fair and properly reflects the progress of the GRRS program to make security upgrades at vulnerable, high risk research reactors worldwide. NNSA also outlined the actions that it plans to take to address the report's recommendations to further improve research reactor security. The complete text of NNSA's comments are presented in appendix I. NNSA also provided technical clarifications, which we incorporated into the report as appropriate.

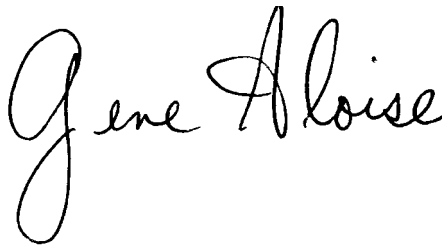
To address the report's recommendations, NNSA stated that it plans to assist countries in meeting security obligations by 1) ensuring that its security policies and procedures, including those for emergency response

to security incidents, fully meet IAEA guidelines and 2) working in cooperation with IAEA's Office of Nuclear Security to encourage the development, where needed, of national security laws and regulations to ensure the safe and secure operation of research reactors

We are sending copies of this report to the appropriate congressional committees; the Secretary of Energy; the Administrator of NNSA; and the Director, Office of Management and Budget. The report will also 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 contact me at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in Appendix II.

Sincerely yours,



Gene Aloise
Director, Natural Resources
and Environment

# Appendix I: Comments from the National Nuclear Security Administration


**Department of Energy**
**National Nuclear Security Administration**
Washington, DC 20585

SEP 3 2009

Mr. Gene Aloise
Director
Natural Resources and Environment
Government Accountability Office
Washington, DC 20548

Dear Mr. Aloise:

The National Nuclear Security Administration (NNSA) appreciates the opportunity to review the Government Accountability Office's (GAO) draft report, GAO-09-949, *Nuclear Nonproliferation: NNSA Has Improved the Security of Research Reactors in its Global Research Reactor Security Program, but Further Action is Needed to Address Remaining Concerns*. We understand that this work was done at the request of the Chairman, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives to review the risks to the United States national security of highly enriched uranium (HEU) used in research reactors in countries of proliferation concerns.

Overall, NNSA believes the report is fair and properly reflects the significant progress the Global Threat Reduction Initiative (GTRI) has made to complete sustainable security upgrades at vulnerable, high risk research reactors worldwide. We agree with the conclusion that the most effective security improvements that can be made at these research reactors is to convert them to the use of low enriched uranium and to remove the HEU from the site.

There are two points in the report that we believe are in need of clarification. The first clarification is that improved security is achieved either through physical protection upgrades or timely removal of HEU from the site. This is reflected in the text from page 10 of the report that states "NNSA plans to complete upgrades or remove all HEU prior to upgrades at the remaining four reactors and to make further upgrades at some reactors where some upgrades have already been made, spending an additional $6 million before ending the program in 2010". However, the second sentence of the summary states that "NNSA plans to complete the program by upgrading the remaining reactors by 2010 at an additional cost of $6 million." We suggest the second sentence in the summary be revised as follows in order to more accurately reflect the state of the program: "NNSA plans to complete upgrades or remove all HEU prior to upgrades at the remaining four reactors and to make further upgrades at some research reactors where some upgrades have already been made, spending an additional $6 million before ending **physical security upgrades** in 2010."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The second clarification is that the GRRS program will not end in 2010 due to continued efforts to sustain the upgrades already implemented. Thus it is more accurate to state that physical protection upgrades will end in 2010 and efforts to sustain these upgrades will continue after 2010. On page 21-22 of the GAO report, its states that "...under its current plans, NNSA plans to complete upgrades at the remaining reactors and end the Global Research Reactors Security (GRRS) program in 2010..." This generality is not consistent with GTRI's work plans or other statements that GAO makes in the report:

- "Recently, NNSA has begun working with IAEA's Office of Nuclear Security to establish a sustainability program to help ensure the continued effectiveness of NNSA-funded security upgrades and to help research reactor operators implement security procedures." (summary)
- "NNSA and IAEA have begun coordinating on a sustainability project to help ensure that research reactor operators adequately maintain NNSA funded upgrades by assisting in the development of equipment testing and maintenance procedures and the development of emergency plans." (page 17)
- "NNSA also plans to spend an additional $378,000 for maintenance and sustainability of the security system at this facility over the next several years" (page 11)
- "In addition, NNSA works with officials in countries included in the GRRS program to develop emergency plans and training exercises with on-site guard forces as well as local, regional, and national law enforcement agencies" (page 13 and then goes on to give a detailed example)
- "To help ensure that the upgrades are sustained, NNSA and Sandia officials periodically visit research reactors to review the condition of upgrades and to determine if supplemental upgrades are needed" (page 18)
- "NNSA has also been purchasing warranty and maintenance contracts for recently installed upgrades and for certain reactors where upgrades are several years old and foreign government research reactor operators lack sufficient funding for maintenance activities. NNSA requires the countries or reactor operators who receive these warranty and maintenance contracts to provide written assurances that they will continue to sustain the upgrades at their own expense after the contract expires, although NNSA will consider providing additional coverage on a case-by-case basis. In addition, NNSA is working with the IAEA and governments in each of the countries that received security upgrades at research reactors to develop a long-term sustainability plan for security systems." (page 19)

This change should also be made in the last sentence of summary page since the program does not end in 2010. We suggest the last sentence be revised to state the following: "NNSA will continue to support sustainability efforts through the IAEA after the completion of security upgrades at the remaining reactors in 2010."

With regards to the recommendation, we recognize that even good programs can get better, and we are committed to quickly and effectively addressing GAO's recommendations for further improvement. We agree with the GAO statement that "Each nation that possesses a research reactor is responsible for the security of its own research reactors." We plan to assist these countries in meeting their security obligations by:

- Ensuring that their security policies and procedures, including those for emergency response to security incidents, fully meet IAEA guidelines as GTRI currently is doing at research reactors domestically; and,

- Working in cooperation with the IAEA's Office of Nuclear Security to encourage the development, where needed, of national security laws and regulations to ensure the safe and secure operation of research reactors.

We thank the GAO team for providing an independent validation that NNSA/GTRI has improved security of this vulnerable, high risk nuclear material. GAO has provided constructive recommendations to further ensure these improvements are sustained. We also appreciate GAO's recognition of GTRI's efforts to accelerate reactor conversions and the HEU returns.

Should you have any questions related to this response, please contact JoAnne Parker, Acting Director, Policy and Internal Controls Management at 202-586-1913.

Sincerely,

Michael C. Kane
Associate Administrator
for Management and Administration

cc: Deputy Administrator for Defense Nuclear Nonproliferation

# Appendix II: GAO Contact and Staff Acknowledgments

## GAO Contact

Gene Aloise, (202) 512-3841 or aloisee@gao.gov

## Staff Acknowledgments

In addition to the individual named above, Ryan T. Coles, Assistant Director; Patrick Bernard; Omari Norman; Tim Persons; Ramon Rodriguez; Peter Ruedel; Rebecca Shea; Carol Herrnstadt Shulman; and Jeanette Soares made key contributions to this report.

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