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

June 2004

NUCLEAR NONPROLIFERATION

DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain

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GAO-04-662

June 2004

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Highlights

Highlights of GAO-04-662, a report to the Chairman, Subcommittee on Emerging Threats and Capabilities, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

Russia's continued operation of three plutonium production reactors poses a serious proliferation threat. The Department of Energy's (DOE) Elimination of Weapons-Grade Plutonium Production program seeks to facilitate the reactors' closure by building or refurbishing replacement fossil fuel plants. This report (1) describes DOE's efforts to manage and implement the program, (2) assesses the challenges DOE faces in achieving its goal of shutting down the reactors, and (3) identifies DOE's current expenditures and projected program costs.

What GAO Recommends

GAO recommends, among other things, that DOE (1) reach agreement with Russia on the steps that must be taken to shut down the reactors and the conditions necessary to complete the fossil fuel plants; (2) amend the reactor shutdown agreement to reflect DOE's revised completion dates for the fossil fuel plants; and (3) develop a plan, in conjunction with Russia, to address the problem of employing nuclear workers who will lose their jobs when the reactors are closed.
DOE agreed to implement our recommendations. The Department of State disagreed with our recommendation that DOE consider seeking funds from Russia to construct the fossil fuel plants. DOE plans to seek financial support provided that it does not delay the program.

www.gao.gov/cgi-bin/getrpt?GAO-04-662.

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.
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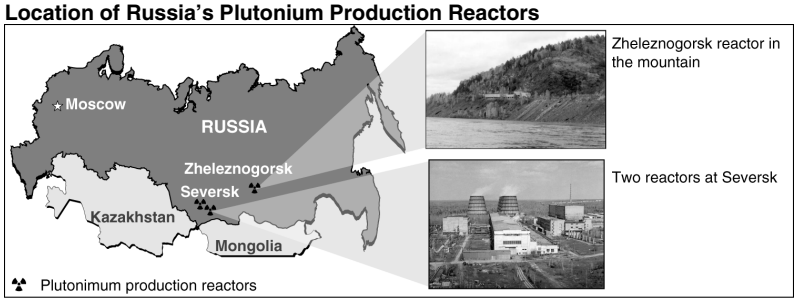
What GAO Found

DOE is financing and managing the construction of two fossil fuel plants in Russia that will replace the heat and electricity that will be lost with the shutdown of Russia's three plutonium production reactors. DOE (1) has developed an overall plan to manage its program, (2) has selected two U.S. contractors to oversee the construction of replacement fossil fuel plants, and (3) is working with its U.S. contractors to review specific design and construction plans for the plants. DOE officials expressed concern that the number of organizations, 17, involved in the program makes coordination difficult and has led to delays. Additionally, DOE and U.S. contractor officials said that the primary Russian contractor may not have adequate experience and currently lacks enough staff to implement its part of the program.

Final shutdown of the reactors is uncertain because DOE faces a number of challenges in implementing its program, including (1) ensuring Russia's commitment to the nonproliferation and safety goals of the program, (2) clarifying the existing reactor shutdown agreement, and (3) working with Russia to find employment for thousands of Russian nuclear workers who will lose their jobs when the reactors are closed. Russia's rejection of DOE's proposals to reduce the amount of plutonium produced by the reactors and to improve the safety of the reactors before they are shut down raises serious questions about Russia's commitment to key program goals. Furthermore, the existing reactor shutdown agreement contains shutdown dates that do not reflect DOE's planned program schedule. Finally, the challenge of finding employment for Russian nuclear workers could undermine the program by creating the potential for Russia to continue operating the reactors longer than necessary to ensure jobs for the workers. DOE has not developed a plan to address this issue.

As of December 31, 2003, DOE had spent $7.8 million—about 4 percent of available funds on planning and developing the program, including travel, overhead, project administration, and document translation costs. Regarding future program costs, DOE officials told us that they expect the projected costs to build the replacement fossil fuel plants to be significantly higher than their original estimate of $466 million, possibly as much as $1 billion.

Location of Russia's Plutonium Production Reactors



Sources: GAO and DOE.

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Abbreviations

CTR	Cooperative Threat Reduction
CD	Critical Decision
DOD	Department of Defense
DOE	Department of Energy
OKBM	Experimental Design Bureau for Machine Building
IPP	Initiatives for Proliferation Prevention
ISTC	International Science and Technology Center
MINATOM	Ministry of Atomic Energy of the Russian Federation
NSC	National Security Council
NCI	Nuclear Cities Initiative
OMB	Office of Management and Budget
PNNL	Pacific Northwest National Laboratory
RTI	Russian Transition Initiatives
WGI	Washington Group International

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United States General Accounting Office
Washington, D.C. 20548

June 4, 2004

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

Dear Mr. Chairman:

Russia's continued operation of three plutonium production reactors, which together produce enough weapons-grade plutonium[1] each year for about 300 nuclear weapons, poses a serious proliferation threat. This plutonium—up to 1.2 metric tons produced annually—is being added to Russia's already vast stockpile of weapons-usable nuclear material. The shutdown of these reactors has been a long-standing nonproliferation goal of the United States, and efforts to secure their closure have continued for over a decade. By 1992, Russia had shut down all but 3 of its 13 plutonium production reactors—2 continue to operate in the closed nuclear city of Seversk and 1 in the closed nuclear city of Zheleznogorsk.[2] While the primary role of plutonium production reactors in the former Soviet Union was to produce weapons-grade plutonium, some of the reactors, including the three that remain in operation, were also designed to generate heat and electricity for nearby cities. Because temperatures in these cities can drop to -40 degrees Fahrenheit in winter and the nearly 300,000 Russians living there depend on the reactors for heat and electricity, alternate heat and power sources must be made available before the reactors can be shut down.

In addition to producing weapons-grade plutonium, these reactors are considered by U.S. and Russian experts to be among the most unsafe in the world. These reactors do not have a containment structure, generally a steel-lined concrete, dome-like structure that serves as the ultimate barrier

[1]Weapons-grade plutonium consists of at least 90 percent of the isotope plutonium-239.

[2]Ten closed nuclear cities formed the core of the former Soviet Union's nuclear weapons complex. Many of the cities are located in geographically remote locations and were so secret that they did not appear on any publicly available maps until 1992. In 1992, Russia changed the names of the closed cities to which we refer in this report: Tomsk-7 became known as Seversk, and Krasnoyarsk-26 became known as Zheleznogorsk. For more information on Seversk and Zheleznogorsk, see appendix I.

to the release of radioactive material during an accident. Furthermore, the reactors, which were built in the 1960s, have exceeded their original estimated operating life by 20 years.

In 1994, Vice President Gore and Russian Prime Minister Chernomyrdin signed an agreement whereby Russia pledged to (1) shut down its three remaining plutonium production reactors by 2000; (2) not restart any other plutonium production reactors that had been shut down prior to signing of the agreement; and (3) not use plutonium produced by the three reactors in nuclear weapons. At the same time, the United States agreed that it would not restart any of its plutonium production reactors. However, the 1994 agreement never entered into force[3] because the United States and Russia could not agree upon who would pay for alternative sources of heat and electricity to replace the reactors. A new agreement, signed by Gore and Chernomyrdin in 1997, addressed this problem by committing the United States and Russia to share the cost of modifying the cores of the reactors so that they could continue to provide heat and electricity while no longer producing spent (used) fuel that could be easily converted into weapons-grade plutonium. This agreement, which entered into force immediately, banned the restart of previously shutdown plutonium production reactors, prohibited Russia's use of newly produced plutonium in nuclear weapons, and established a monitoring regime under which U.S. and Russian personnel regularly inspect previously shutdown plutonium production reactors. In addition, under the agreement, U.S. representatives verify the quantities of plutonium that have been produced by the three Russian reactors since 1997 and determine that this material is kept in storage rather than being used in nuclear weapons. Also in 1997, the Department of Defense (DOD) was assigned formal responsibility for managing the U.S. effort to modify the reactors, with technical assistance from the Department of Energy (DOE) and its national laboratories. Between fiscal years 1994 and 2001, the United States spent approximately $42.5 million to explore the feasibility of modifying the reactors.[4] However, numerous

[3]An agreement enters into force the moment all provisions become legally binding on its parties.

[4]The total funding for U.S. efforts to eliminate weapons-grade plutonium production in Russia between fiscal years 1994 and 2001 includes funds provided by DOD, DOE, the U.S. Trade and Development Agency, and the Department of State's Nonproliferation and Disarmament Fund. The total funding amount has been adjusted to constant fiscal year 2003 dollars.

technical and political obstacles slowed the effort to modify the reactors, and the program languished.

In 2001, the United States and Russia agreed to pursue another option to bring about the closure of the reactors: building or refurbishing fossil fuel plants to replace a significant amount of the heat and electricity now produced by the reactors. The management of the program was transferred from DOD to DOE in December 2002, as the result of a review of all U.S. nonproliferation programs led by the National Security Council. The National Nuclear Security Administration manages DOE's effort, which is known as the Elimination of Weapons-Grade Plutonium Production program (hereafter referred to as the program).[5] In March 2003, the Secretary of Energy and the Minister of Atomic Energy of the Russian Federation (MINATOM)[6] signed an amendment to the 1997 agreement, as well as a new implementing reactor shutdown agreement between DOE and MINATOM, whereby the United States agreed to fund the construction or refurbishment of two fossil fuel plants to replace the three plutonium production reactors. Russia agreed to shut down all three reactors by 2006. Specifically, Russia agreed to shut down the reactors as soon as the replacement fossil fuel plants are able to provide sufficient heat and electricity to the cities of Seversk and Zheleznogorsk.[7] The agreement also stated that Russia would (1) assume responsibility for the fuel, operation, and maintenance of the replacement fossil fuel plants and for their

[5]The National Nuclear Security Administration is a separately organized agency within DOE that was created in October 1999 with responsibility for the nation's nuclear weapons, nonproliferation, and naval reactors programs.

[6]MINATOM was downgraded to a noncabinet level agency within the Russian bureaucracy in March 2004 by order of the President of Russia. Oversight of its operation of defense-related nuclear enterprises was transferred to the Ministry of Defense and oversight of its civilian nuclear activities was transferred to the newly created Ministry of Industry and Energy. DOE officials told us they thought this reorganization would not affect the program.

[7]According to the agreement, the two reactors at Seversk will be permanently shut down when DOE provides assistance to supply heat and electricity at a maximum capacity of up to 1560 gigacalories of steam generation per hour and up to 235 megawatts of electricity generation. Shutdown of the Zheleznogorsk reactor is to occur when DOE provides assistance to supply heat and electrical capacity of up to 660 gigacalories of steam generation per hour and up to 117 megawatts of electricity generation. A gigacalorie is a thermal energy measurement equal to one billion calories. A megawatt is a measurement of electrical power equal to one million watts.

commissioning and (2) remain responsible for the decommissioning of the plutonium production reactors following their shutdown.[8]

In this context, you asked us to review DOE's program to help Russia shut down these reactors. This report (1) describes DOE's efforts to manage and implement the program since it was transferred from DOD, (2) assesses the challenges that DOE faces in achieving its goal of shutting down the reactors, and (3) identifies DOE's current expenditures and projected costs to implement the program. To address these objectives, we interviewed U.S. officials from DOE, DOD, and the Department of State (State), the Nuclear Regulatory Commission, the Pacific Northwest National Laboratory (PNNL), and the National Energy Technology Laboratory on matters related to U.S. efforts to secure the shutdown of Russia's plutonium production reactors. In September 2003, we interviewed officials in Moscow from the Ministry of Atomic Energy of the Russian Federation; Rosatomstroi, the primary Russian contractor; and Gosatomnadzor, the Russian nuclear regulatory agency. In addition, we went to the cities of Seversk and Zheleznogorsk, where the plutonium production reactors are currently in operation and interviewed scientists, plant managers, city officials, and reactor operators. We also analyzed current program cost and expenditure data from DOE. More detail on our scope and methodology can be found in appendix II. We conducted our work between June 2003 and April 2004 in accordance with generally accepted government auditing standards.

Results in Brief

Since the program was transferred from DOD in December 2002, DOE (1) has developed an overall program plan to manage the construction of the two fossil fuel plants that emphasizes project planning, risk reduction, and periodic progress reviews by senior DOE officials; (2) has selected two U.S. contractors to oversee the construction of the replacement fossil fuel plants; and (3) is working with its U.S. contractors to review specific design and construction plans for the plants. DOE plans to complete plant construction by 2008 in Seversk and 2011 in Zheleznogorsk. There are 17 organizations involved in managing the program, providing technical assistance, and performing support tasks. In addition, there are numerous Russian subcontractors who will be responsible for manufacturing,

[8]Decommissioning of a nuclear power plant is the process of closing down a facility followed by reducing residual radioactivity to a level that permits the release of property for unrestricted use.

supplying, or installing equipment for the plants. DOE officials expressed concern that the number of organizations involved in the overall management of the program makes coordination difficult and has led to delays. For example, at Zheleznogorsk, the acquisition of the proposed site for the replacement fossil fuel plant was delayed for 9 months because of a dispute over the value of the land among the Ministry of Atomic Energy of the Russian Federation; the Mining and Chemical Combine, which is responsible for operating the reactor; and a local Siberian power utility. Additionally, DOE and U.S. contractor officials told us that the primary Russian contractor, Rosatomstroi, has not previously worked with U.S. contractors on large-scale construction projects and currently lacks enough staff to effectively implement its part of the program, overseeing the Russian subcontractors. Rosatomstroi officials told us that DOE's use of two U.S. contractors to oversee the projects is burdensome because it forces them to adapt to different management styles and reporting requirements. To help improve program management, DOE plans to hire a resident officer in charge of construction who will reside in Russia for the duration of the program. The resident officer's responsibilities will include (1) ensuring that contractual work is carried out, (2) providing daily reviews of contractor progress, (3) monitoring the quality of work being performed, and (4) assisting in early identification and resolution of problems.

Final shutdown of Russia's three plutonium production reactors is uncertain because DOE faces challenges in implementing its program, including (1) ensuring Russia's commitment to key nonproliferation and safety goals of the program, (2) clarifying the existing reactor shutdown agreement, and (3) working with Russia to find employment for the thousands of Russian nuclear workers who are currently employed at the reactors and related facilities. Regarding these challenges:

- DOE officials told us that Russia's recent rejection of its proposal to reduce the amount of plutonium being produced by the reactors raises serious questions about Russia's commitment to the fundamental nonproliferation goal of the program. DOE and Russian officials had identified options to reduce the reactors output of plutonium, including extending the period during the summer when the reactors are shut down for maintenance and refueling. However, in November 2003, the Ministry of Atomic Energy of the Russian Federation informed DOE that it did not wish to pursue this option and instead asked DOE to concentrate its efforts on accelerating the completion of the fossil fuel plants. DOE also planned to improve the safety of the reactors by

funding a $21 million effort consisting of 28 safety upgrade projects, including fire safety improvements and enhancements to emergency electrical power systems. However, in February 2004, the Ministry of Atomic Energy rejected DOE's planned assistance for safety upgrades and stated that it would undertake its own safety improvements. DOE officials told us that they were pessimistic about the likelihood that Russia would install any safety upgrades at the reactors.

- The existing reactor shutdown agreement does not specify the steps and period of time needed to complete the shutdown of the reactors, or the specific requirements that must be met to license and commission the replacement fossil fuel plants. Additionally, DOE and State officials told us that the shutdown dates in the agreement will have to be revised to reflect DOE's most recent planned construction schedule for the fossil fuel plants.

- DOE officials said that helping Russia find jobs for the thousands of nuclear workers who are currently employed at the reactors and related facilities and will be displaced when the reactors are shut down will be a major challenge. Although DOE officials told us that a failure to find jobs for these workers could threaten the success of the program, DOE has not developed a plan to coordinate the shutdown of the reactors with other DOE and State efforts designed to find employment for Russian nuclear workers.

As of December 31, 2003, DOE had spent $7.8 million, or about 4 percent of available funds, to begin work on planning and developing the program, including travel, overhead, project administration, and document translation costs. To date, DOE has had a slow rate of spending on program activities, which has led to a large balance of unobligated and unspent program funds. DOE officials expect the program's obligations and expenditures to increase significantly when the Seversk project moves from the design phase to the construction phase near the end of fiscal year 2004 and the Zheleznogorsk project moves into the construction phase in the second quarter of fiscal year 2005.

Additionally, DOE officials told us that they expect the costs to build the replacement fossil fuel plants to be significantly higher than their original estimates. The total cost to build the replacement fossil fuel plants, which DOE had earlier projected to be $466 million, remains uncertain, in part, because this estimate is based on Russian cost projections that DOE has not yet validated. However, according to DOE officials, the actual

construction costs for the plants are likely to be significantly higher than the original estimate and may be as much as $1 billion, because of a number of factors, including the high rate of inflation in Russia and higher than projected Russian labor costs. DOE and its contractors are currently reviewing the Russian cost projections and revising the preliminary cost estimate to reflect changes to the projects' schedule and scope. DOE plans to bear full financial responsibility for building the replacement fossil fuel plants, which will be designed and built by Russia. DOE, State, and National Security Council officials told us that the United States did not insist that Russia commit financial resources to building the plants out of concern that Russia might be unable to fulfill its financial obligations to the program, which would delay the shutdown of the reactors. Because the United States has agreed to fully fund the costs of the replacement plants, Russia has little incentive to control construction costs.

This report makes recommendations to improve the management of the program and increase its chance for success. Among other things, it recommends that DOE (1) reach agreement with Russia on the steps that must be taken to permanently shut down the reactors and what specific requirements must be met to complete the replacement fossil fuel plants, (2) amend the reactor shutdown agreement to reflect DOE's revised completion dates for the fossil fuel plants, (3) develop a plan and take steps to formally coordinate its program with existing DOE and Department of State programs to employ Russian nuclear workers, and (4) consider seeking financial support from Russia to construct the fossil fuel plants.

We provided draft copies of this report to the Departments of Energy and State for their review and comment. DOE agreed to implement our recommendations. State agreed with all of our recommendations except one that DOE should consider seeking financial support from Russia to construct replacement fossil fuel plants. DOE also expressed concern with our conclusion regarding this matter. Both agencies stated that relying on Russia to fund critical program elements would pose a significant risk. However, DOE agreed to pursue obtaining additional financial support from Russia provided it does not delay the program.

Background

During the Cold War, the United States and the Soviet Union built a total of 27 nuclear reactors to produce weapons-grade plutonium for nuclear weapons. Although all nuclear reactors produce plutonium as a byproduct of their operation, plutonium production reactors are specifically designed to produce a concentrated isotope of plutonium that is more readily used in

nuclear weapons. (See app. III for additional information about the plutonium production nuclear fuel cycle.) The United States constructed 14 plutonium production reactors of which only one, the N-reactor at Hanford, Washington, produced electricity in addition to weapons-grade plutonium. This reactor was shut down in 1987 for safety upgrades following the Chernobyl accident and never resumed operation. The United States had shut down all of its plutonium production reactors by 1989.

The Soviet Union built 13 plutonium production reactors, and all but 3 have been shut down. (For a time line showing the history of these reactors and efforts to bring about their closure, see app. IV.) The three remaining reactors began operating between 1964 and 1968, and U.S. and Russian nuclear experts told us that these reactors are among the most dangerous in the world due to their age and poor design. In addition, the reactors lack safety features such as a containment structure, which is generally a steel-lined concrete, dome-like structure that serves as a barrier to the release of radioactive material during an accident. The lack of containment presents a greater risk for the two reactors at Seversk because, unlike the reactor at Zheleznogorsk, which is located inside a mountain, the Seversk reactors are above ground. Figure 1 shows the location of the Russian reactors.

Figure 1: Location of Russia's Three Plutonium Production Reactors

Sources: GAO and DOE.

According to Russian officials in Seversk, the two reactors currently provide about 70 percent of the heat and electricity for the city's residents. However, the reactors have the capacity to produce more heat and electricity than is needed to meet the demands of Seversk's residents, and both heat and electricity have been sold to the nearby city of Tomsk since 1973. Officials in Zheleznogorsk told us that the reactor there provides 60 percent of the city's heat and 98 percent of its electricity. The amounts of replacement heat and electricity that the United States and Russia agreed to in the March 2003 reactor shutdown agreement are less than what is currently provided by the reactors, but Russian officials from both cities told us the agreed upon amounts would be sufficient to meet their needs once the reactors are shut down.

Commissioned in the mid-1960s, the three reactors have continued to operate although, according to Russian officials, they were originally designed to have an operating life of 20 years. Officials from Russia's nuclear regulatory agency, Gosatomnadzor, told us that since the 1960s, there have been at least three serious accidents and several minor incidents at one of the Seversk reactors. For example, in 1966, a coolant pipe ruptured, resulting in the release of contaminants into the atmosphere near the reactor site. Subsequently, the same reactor experienced a partial meltdown that damaged part of the core. Finally, in 1999, the reactor experienced another serious incident when spent fuel was ejected onto the top of the reactor.

DOE Has Overall Program Plan in Place, but the Large Number of Organizations Involved in the Program Could Delay Progress

Since the program was transferred from DOD to DOE in December 2002, DOE (1) has developed an overall program plan to manage the construction of the fossil fuel plants, (2) has selected two U.S. contractors to oversee work on the replacement fossil fuel plants, and (3) is working with its U.S. contractors to review design and construction plans for the plants. DOE plans to complete refurbishment of the plant in Seversk by 2008 and construction of the plant in Zheleznogorsk by 2011. However, U.S. and Russian officials expressed concern that the large number of U.S. and Russian organizations, 17, involved in the overall management of the program makes coordination difficult and has led to delays. Additionally, DOE and U.S. contractor officials told us that the primary Russian contractor, Rosatomstroi, has not previously worked with U.S. contractors on large-scale construction projects and currently lacks enough staff to effectively implement its part of the program, overseeing the Russian subcontractors, which could lead to delays.

DOE Developed an Overall Plan to Manage the Program, Hired Contractors, and Is Reviewing Specific Design and Construction Plans for the Fossil Fuel Plants

DOE has developed an overall management plan for its program that (1) emphasizes detailed project planning, (2) seeks to identify project risks, and (3) develops alternative strategies to reduce risks. The program management elements in DOE's plan are detailed in DOE order 413.3, which the department uses for construction projects and the acquisition of capital assets in the United States. Under DOE order 413.3, the program will move through five critical decision points, the major stages of design and construction, upon the approval of DOE's Deputy Secretary. These critical decisions are formal determinations that allow the project to proceed to the next phase and commit additional resources. Critical decisions are required during the planning and execution of a project, for example, before beginning conceptual design,[9] before starting construction, and when beginning operations. (For more detailed information about DOE's management plan, see app. V.)

DOE has also selected two U.S. contractors to oversee work on the two plants. In mid-2003, DOE awarded contracts to (1) Washington Group International (WGI) to oversee Russia's refurbishment of an existing fossil fuel plant at Seversk and (2) Raytheon Technical Services (Raytheon) to oversee Russia's construction of a new fossil fuel plant at Zheleznogorsk. These contracts cover the preliminary design phase of the projects. DOE plans to evaluate the performance of both contractors at the conclusion of the preliminary design phase. According to DOE, an extension or new contract would be required to cover the final design phase, construction, and closeout phases. In addition, DOE employs the National Energy Technology Laboratory, a DOE national laboratory that has historically focused on the development of advanced technologies related to coal and natural gas, to accomplish various management support tasks.

Finally, DOE, together with its contractors, is reviewing the detailed design and construction plans that Russian subcontractors are developing for the fossil fuel plants at Seversk and Zheleznogorsk. At Seversk, DOE plans to refurbish an existing fossil fuel plant, which was built in 1953. To meet the heat and electricity production levels specified in the March 2003 agreement, DOE plans to replace one boiler (boilers burn coal to produce heat and steam); upgrade the plant's 12 existing boilers to improve their

[9]Conceptual design is the concept for meeting a mission need. The conceptual design process requires a mission need as an input. Concepts for meeting the need are explored and alternatives considered arriving at the set of alternatives that are technically viable, affordable, and sustainable.

efficiency and performance; and replace three turbine-generators, which use the steam produced by the boilers to generate electricity. (See app. VI for more information about the operation of coal-fired power plants.) In addition, DOE plans to improve the infrastructure at the plant by, among other things, enhancing the coal-handling system and improving the plant's water chemistry system. DOE plans to complete the refurbishment of the fossil fuel plant at Seversk by 2008. At Zheleznogorsk, DOE plans to construct a new fossil fuel power plant that is powered by coal to meet the heat and electricity production levels specified in the March 2003 agreement. This new plant is scheduled for completion in 2011. Since the plants are being built to Russian standards, DOE plans to use Russian environmental, safety, and health standards in the construction of the fossil fuel plants rather than U.S. standards. However, in addition to satisfying all Russian regulations, DOE's contractors are responsible for identifying potential environmental concerns resulting from emissions at the plants and comparing the Russian environmental standards with applicable international standards.

Concerns Exist About the Large Number of Program Participants and the Primary Russian Contractor's Lack of Experience and Staff

We identified 17 U.S. and Russian organizations that are participating in the program. In total, these organizations have a variety of roles and responsibilities, including setting policy and direction, providing technical assistance, and managing and overseeing the program. In addition, there are numerous Russian subcontractors who will be responsible for supplying, manufacturing, or installing equipment for the replacement fossil fuel plants. Specifically, in addition to DOE, the U.S. organizations participating in the program include the following:

- The National Nuclear Security Administration, a separately organized agency within DOE that oversees the program;
- Washington Group International is DOE's primary integrating contractor for refurbishing the Seversk replacement fossil fuel plant;
- Raytheon Technical Services is DOE's primary integrating contractor for building the Zheleznogorsk plant. Raytheon has subcontracted some of its work to the U.S. construction firm Fluor;
- The National Energy Technology Laboratory performs various management support tasks for DOE and has two primary subcontractors, Energy and Environmental Solutions and Concurrent Technologies Corporation, which provide management support to

DOE's program. Additionally, Concurrent Technologies Corporation subcontracts some work on the program to Parsons; and

- PNNL had been the lead contractor for DOE's planned Nuclear Safety Upgrades Project. Though this project was cancelled in February 2004, PNNL will still have limited participation in developing a reactor shutdown plan.

In addition to MINATOM, numerous Russian participants in the program include the following:

- Rosatomstroi, the primary Russian contractor working for MINATOM on building the replacement fossil fuel plants;

- Tvel-Finance supports WGI on the Seversk fossil fuel plant project and is a subcontractor to Rosatomstroi;

- The Siberian Chemical Combine in Seversk operates the two reactors there and owns the fossil fuel plant that DOE plans to refurbish;

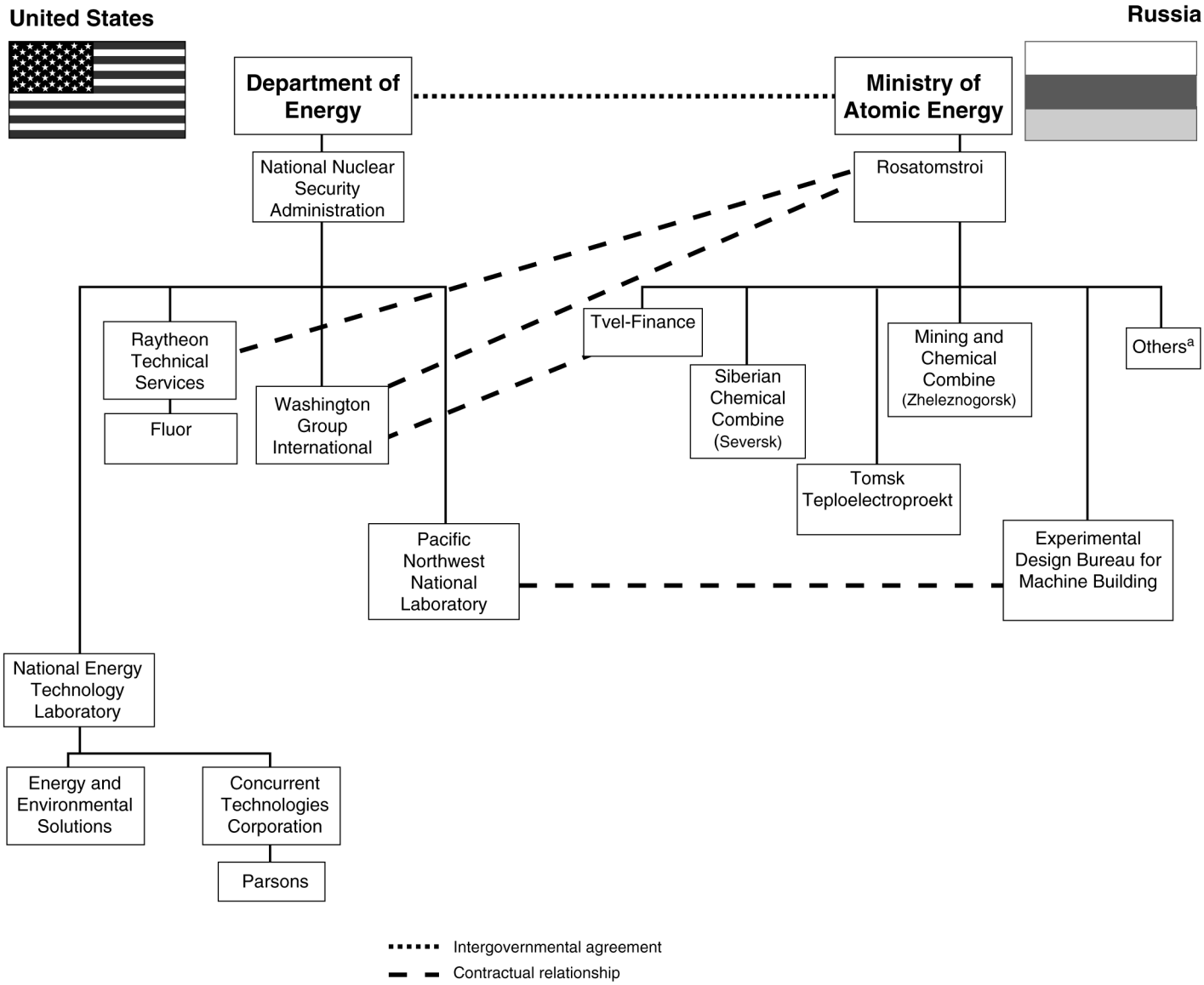
- Tomsk Teploelectroproekt is a subcontractor to Rosatomstroi and is responsible for developing the refurbishment design for the replacement fossil fuel plant at Seversk;

- The Mining and Chemical Combine operates the reactor in Zheleznogorsk; and

- The Experimental Design Bureau for Machine Building (OKBM) was involved in the development of many of DOE's planned safety upgrades for the reactors and is involved in developing the reactor shutdown plan.

Figure 2 shows the relationships between key program participants.

Figure 2: Organizational Relationships in DOE's Elimination of Weapons-Grade Plutonium Production Program



Sources: GAO; Nova Development (clip art).

[a]Other Russian subcontractors include additional design institutes and manufacturers of parts and equipment for the replacement fossil fuel plants.

DOE officials told us that the numerous organizations involved in managing this complex program makes coordination difficult and has led to delays. For example, at Zheleznogorsk, the acquisition of the proposed site to build the replacement fossil fuel plant was delayed for 9 months because a dispute over the value of the land among MINATOM; the Mining and Chemical Combine, which is responsible for operating the reactor; and a local Siberian power utility. Raytheon officials told us that the project experienced a "day-to-day" slippage while the land acquisition issue remained unresolved. To improve program management, DOE plans to hire a resident officer in charge of construction who will reside in Russia for the duration of the program. Specifically, the resident officer's responsibilities will include (1) ensuring that contractual work is carried out, (2) providing daily reviews of contractor progress, (3) monitoring the quality of work being performed, and (4) assisting in early identification and resolution of construction problems.

DOE and U.S. contractor officials also told us that the primary Russian contractor, Rosatomstroi, has not previously worked with U.S. contractors on large-scale construction projects and does not currently have staff to effectively implement its part of the program, which may lead to additional program delays. Rosatomstroi was created in 2002 and has a limited budget and little authority to make decisions on behalf of the Russian government without the approval of MINATOM. Because MINATOM designated Rosatomstroi as the primary Russian integrating contractor, DOE must rely on Rosatomstroi to manage Russia's part of the program, which includes overseeing the numerous Russian subcontractors. Rosatomstroi officials told us in September 2003 that they had 8 employees dedicated to the program but that they plan to add about 40 additional staff as the Seversk and Zheleznogorsk fossil fuel plant projects progress from the design phase to construction. Officials from both U.S. contractors said that one of their most difficult initial tasks has been to mentor Rosatomstroi personnel on project management and Western business practices. WGI officials told us that this task has taken much-needed time away from other planning aspects of the Seversk project. For their part, Rosatomstroi officials expressed concern that DOE's use of two U.S. integrating contractors to provide day-to-day project oversight is burdensome because it forces them to adapt to different management systems and reporting requirements.

Despite their efforts to develop a sound management structure, DOE officials told us that successful program implementation ultimately depends on Russia's commitment and cooperation. A recent assessment of DOE's program by the Office of Management and Budget (OMB) reinforces

the need for Russia's cooperation to improve the program's chances for success.[10] OMB pointed out that DOE must rely on Russia to create conditions that will not limit the effectiveness and efficiency of the program to shut down the reactors. Furthermore, OMB stated that Russia's creation of these conditions is largely out of DOE's control and is a potential flaw in the structure of the program. However, a Department of State official told us that he believes Russia has every incentive to cooperate in the program because shutting down the reactors and obtaining replacement heat and electricity sources is in Russia's interest.

DOE Faces Challenges in Its Efforts to Shut Down the Reactors, Including Obtaining Russia's Support to Implement Key Nonproliferation and Safety Initiatives

Final shutdown of Russia's three plutonium production reactors is uncertain because DOE faces challenges in implementing its program. Perhaps the most important of these challenges is ensuring Russia's commitment to key aspects of the program. Russia's recent rejection of DOE's initiatives to reduce the amount of plutonium being produced by the reactors and to improve the safety of the reactors prior to their shutdown raises serious questions about Russia's commitment to the fundamental nonproliferation and safety goals of the program. A second challenge DOE faces is that the existing reactor shutdown agreement does not specify the steps needed to complete the shutdown of the reactors and the specific requirements that must be met to license and commission the replacement fossil fuel plants. Furthermore, the agreement contains shutdown dates that are not realistic. Finally, thousands of Russian nuclear workers who are currently employed at the reactors and related facilities will be displaced when the reactors are closed. Although DOE officials told us that a failure to find jobs for these workers could threaten the success of the program, DOE has not developed a plan to coordinate the shutdown of the reactors with other DOE and Department of State efforts designed to find employment for Russian nuclear workers.

[10] *Department of Energy PART [Program Assessment Rating Tool] Assessments*, Office of Management and Budget (Washington, D.C.: February 2004). We recently reported on the Office of Management and Budget's Program Assessment Rating Tool in *Performance Budgeting: Observations on the Use of OMB's Program Assessment Rating Tool for the Fiscal Year 2004 Budget*, GAO-04-174 (Washington, D.C.: January 30, 2004).

Russia Rejected DOE's Proposal to Reduce the Amount of Plutonium Produced by the Reactors in the Interim before They Are Shut Down

The main nonproliferation goal of DOE's program is to stop Russia's production of weapons-grade plutonium. Because closure of the reactors will not occur until the fossil fuel plants are built and suitable heat and electricity sources are provided, DOE and MINATOM discussed interim measures to reduce the amount of plutonium produced by the reactors before they are shut down, as well as measures to accelerate the reactors' shutdown. According to DOE officials, Russia's support for this initiative would have clearly signaled a commitment to the nonproliferation goal of the program. In July 2003, DOE and Russian officials identified three options to reduce the reactors' output of plutonium while the replacement fossil fuel plants are being built: (1) extending the period during the summer when the reactors are shut down for maintenance and refueling, (2) shutting down one of the two reactors at Seversk once the refurbishment of the fossil fuel plant reaches an agreed-upon level of completion, and (3) shutting down the reactor at Zheleznogorsk before the fossil fuel plant is completed but after it is able to supply an adequate amount of heat to the city. DOE believed that pursuing all of the reduction options could reduce the amount of weapons-grade plutonium produced by the reactors before their planned shutdown dates by up to 25 percent, or one-third metric ton, annually.

DOE officials told us that the first option, extending summer outage periods, held the greatest promise for reducing plutonium production at the earliest possible date, which DOE believed could occur in the summer of 2004. Russian reactor officials in Zheleznogorsk told us that extending summer outage periods would be the easiest option to reduce the production of plutonium. Because the initiative to reduce the production of plutonium is outside the scope of DOE's program to build replacement fossil fuel plants, DOE obtained funding from the Department of State's Nonproliferation and Disarmament Fund to support the estimated $380,000 cost of studying the three plutonium production reduction options.[11] DOE also planned to solicit participation from other countries to help fund these efforts.

In November 2003, the First Deputy Minister of MINATOM stated in a letter to DOE that Russia no longer wanted to explore the possibility of reducing the amount of plutonium produced while the reactors continue to operate

[11]The Department of State's Nonproliferation and Disarmament Fund sponsors specific projects that address high-priority opportunities to halt the proliferation of weapons of mass destruction and other related nonproliferation problems.

and that pursuing such options could affect the time frame of closing the reactors. According to the letter, "[Russia does] not find it worthwhile to waste efforts on a project for reducing plutonium production prior to the permanent shutdown of the reactors." The letter also stated that Russia's main objective was to shut down the reactors as soon as possible. In response to the letter, DOE is no longer pursuing extending summer outages at the reactors as an option for reducing the amount of plutonium produced. A Department of State official told us that Russia's decision to reject this proposal was likely based on its security concerns about providing U.S. personnel with access to the reactors for the purpose of monitoring and verifying the reduced amount of plutonium that would be produced.

In December 2003, MINATOM requested that DOE fund a study to examine the possibility of shutting down one of the Seversk reactors prior to the completion of the replacement fossil fuel plant. To achieve the early closure of one of the reactors, MINATOM proposed that the refurbishment of the Seversk plant could be accelerated through the advanced procurement of certain major components such as the boiler. However, unlike extending the summer outage periods, this option could not be implemented in mid-2004.

DOE Canceled Its $21 Million Program to Improve the Safety of the Reactors after Russia Rejected DOE's Proposed Assistance

As part of the reactor shutdown agreement, DOE pledged to improve the safe operation of the reactors; and to accomplish this goal, DOE planned to fund a $21 million effort, consisting of 28 safety upgrade projects—such as fire safety system improvements, enhancements to emergency electrical power systems, and risk assessments. DOE selected PNNL to oversee the installation of the safety projects. DOE's original plan called for work on the upgrade projects, including design work and contracting activities, to take place during a 24-month period—beginning in mid-2003 and ending by mid-2005—in order to maximize the benefits of the safety enhancements before the reactors are shut down. (See app. VII for a summary of DOE's planned safety upgrade projects.)

However, the start of the program was delayed for several months because the United States and Russia were unable to agree on the amount of background information that Russia required of U.S. workers to submit for Russia's national security review purposes before they would be granted access to the reactors. In February 2004, the failure to resolve this issue led MINATOM to reject DOE's planned assistance to improve the safety of the reactors and instead to say it would undertake necessary safety

improvements on its own. As a result, DOE officials told us they were canceling the safety upgrade project and are considering several options to transfer the remaining unspent project funds to other program areas, including accelerating the completion of the replacement fossil fuel plant at Zheleznogorsk.

DOE's Assistant Deputy Administrator, Office of International Nuclear Safety and Cooperation, told us that he was very pessimistic that Russia would perform the safety upgrades. Additionally, he noted that even if Russia decides to install the upgrades, they may not be of sufficient quality or quantity to reduce the risk posed by the reactors' continued operation. A PNNL program official also expressed doubt that Russia would pursue upgrading the reactors. He noted that without DOE's planned safety upgrades, the reactors would continue to deteriorate until they are finally shut down. None of the reactors would be licensed for operation in the United States or Western countries because they lack modern safety controls, and at least one reactor has experienced structural damage causing obstructions in the channels where control rods are inserted in case the reactor must be shut down in an emergency. The control rods are devices used to control the rate of nuclear reactions in a reactor. In the view of the PNNL official, it is likely that all three reactors have experienced such damage.

The deteriorating safety conditions present a greater danger at the two Seversk reactors than at Zheleznogorsk, because unlike the Zheleznogorsk reactor, the reactors at Seversk are located above ground. Furthermore, one of the Seversk reactors has experienced multiple accidents, including one that resulted in the expulsion of fuel elements onto the top of the reactor in 1999. Based on our analysis, the reactors are showing the wear of having been run for a very long time at a high output. The danger that these reactors present is the risk of a catastrophic reactor failure—such as a loss of coolant accident—which would result in a fire expelling the highly enriched uranium fuel and its fission byproducts such as plutonium and strontium-90, all of which are highly toxic and carcinogenic. The danger from such a fire is that radioactive particles would be dispersed and breathed into the body, causing either kidney damage from particles of uranium or cancer from particles of strontium-90 and plutonium. (For our technical analysis of the safety problems posed by the reactors, see app. VIII.)

Regardless of the safety condition of the reactors, Russian officials stated that they plan to run the reactors until replacement energy is provided to

the residents of Seversk and Zheleznogorsk. Because winter temperatures in the region of the cities can reach -40 degrees Fahrenheit, officials from Gosatomnadzor told us that they would continue issuing operating licenses to the reactors each year unless a "calamity" occurred.

The Reactor Shutdown Agreement Does Not Clearly Specify What Is Required to Shut Down the Reactors and Contains Unrealistic Shutdown Dates

Although the current agreement calls on Russia to shut down the reactors when the replacement fossil fuel plants produce a certain amount of heat and electricity, it does not specify what steps are needed to shut down the reactors;[12] how long it will take to shut down the reactors; or the process for and time required to license and commission the replacement fossil fuel plants. DOE indicated that agreeing on these issues and developing a specific plan of action to complete the program is critical to success. As a result, DOE initiated discussions with Russia to develop a reactor shutdown plan that will detail the activities needed to shut down the reactors and commission the fossil fuel plants. Additionally, the reactor shutdown plan will analyze expenses associated with shutting down the reactors.

Further, the current agreement contains shutdown dates that are unrealistic and do not reflect DOE's planned completion dates for the replacement fossil fuel plants. Under the March 2003 agreement, the United States and Russia agreed that the two reactors in Seversk and the reactor in Zheleznogorsk would stop producing plutonium by December 31, 2005, and December 31, 2006, respectively. However, according to DOE, Department of State, and Russian officials, these dates are no longer realistic because DOE does not plan to complete the replacement fossil fuel plant in Seversk until 2008 or the plant in Zheleznogorsk until 2011. Russian officials have reiterated that they will not shut down the reactors until the agreed-upon replacement power and heat generating capacity are provided by the United States. DOE and Department of State officials told us that the current agreement would be amended to reflect DOE's planned schedule for the completion of the fossil fuel plants once project designs are completed. Failure to secure specific agreement on these changes could put program success at risk as it has for other U.S. nonproliferation efforts.

[12]Under the 1997 Plutonium Production Reactor Agreement, once the reactors are shut down, they will be sealed and inspected annually by U.S. officials to ensure that they remain permanently shut down.

Specifically, in the past, some U.S. nonproliferation efforts that were dependent on Russian cooperation have been canceled or adversely affected in part because of a lack of specific agreements and coordination between relevant U.S. and Russian organizations. Notable examples include two large-scale construction projects in Russia that were managed by DOD under the Cooperative Threat Reduction (CTR) program—a facility to dispose of liquid propellant used to fuel Russian ballistic missiles at Krasnoyarsk and the Fissile Material Storage Facility at Mayak.[13] In both cases, DOD did not secure specific provisions in the agreements that addressed all program risks to the projects.

- In 1993, DOD agreed to help Russia dispose of liquid propellant used to fuel Russian ballistic missiles and eventually agreed to finance the construction of a disposal facility. In February 2002, after $96 million had been spent on the project, DOD officials learned that Russia had used the liquid propellant in its space program but had failed to notify DOD. As a result, DOD canceled construction of the facility and terminated the project. The DOD Inspector General found that Russia used the rocket fuel without DOD's knowledge because the agreements with Russia did not require it to provide the fuel to DOD for disposal and did not provide DOD with access rights over the fuel's storage.[14]

- In another case, the United States agreed to build a storage facility in Mayak, Russia, for fissile materials, including highly enriched uranium and plutonium. However, the agreement did not provide DOD with rights to verify the source of the fissile material to be stored in the facility, nor did it specify the amount or type of fissile material Russia was required to deposit in the facility. By July 2003, DOD had spent $372.8 million on fissile material containers and the design and construction of the facility. However, in July 2003, MINATOM notified DOD that Russia would store only 25 metric tons of plutonium at the facility, while converting its highly enriched uranium into low enriched uranium to sell to the United States for use in civilian nuclear power

[13]The CTR program was authorized by Congress in 1991. Under this authorization, DOD provides assistance to nations of the former Soviet Union to (1) destroy their weapons of mass destruction, (2) safely store and transport the weapons in connection with their destruction, and (3) reduce the risk of the proliferation of such weapons.

[14]*Cooperative Threat Reduction: Cooperative Threat Reduction Program Liquid Propellant Disposition Project;* DOD-2002-154: Department of Defense, Office of the Inspector General (Arlington, VA: September 30, 2002).

plants. As a result, only one-fourth of the facility's storage capacity will be used.[15]

The DOD Inspector General concluded that for future CTR projects, implementing agreements should be negotiated that would "require Russia to provide the United States with all the necessary resources to assure that assistance is used for intended purposes." As a result of congressional concern and in response to recommendations from the DOD Inspector General, the CTR program has taken several steps to protect the investment of U.S. funds and improve program oversight, including replacing good faith obligations from Russia with specific legal commitments before proceeding with any current or future CTR projects.

DOE Has Not Developed a Plan to Coordinate the Shutdown of the Reactors with Other U.S. Efforts to Employ Thousands of Displaced Russian Nuclear Workers

DOE officials told us that worker transition issues at Seversk and Zheleznogorsk have the potential to undermine efforts to shut down the reactors and present major challenges for the program. In July 2002, Russia's First Deputy Minister of Atomic Energy said that the most "acute" problem in downsizing Russia's nuclear weapons complex was at Zheleznogorsk, where the closure of the reactor would lead to the loss of 5,000 to 7,000 jobs in a city where other employment opportunities are limited. He also predicted that the closure of the two reactors in Seversk would lead to the loss of 5,000 to 6,000 additional jobs. Russian officials from both Seversk and Zheleznogorsk told us that finding jobs for displaced workers is their highest priority. Although these officials recognize that Russia is primarily responsible for employing these workers, they are seeking assistance from the United States to help address this problem.

Since many Russian nuclear workers have highly specialized experience manufacturing and processing weapons-grade nuclear material, their unemployment poses a significant proliferation risk because they might sell sensitive nuclear information to terrorists or countries of concern. Specifically, many nuclear workers in Seversk and Zheleznogorsk possess knowledge and skills in machining nuclear material and manufacturing nuclear weapons. Since 2001, Congress has appropriated about $40 million each year to support DOE's efforts to assist Russia in finding employment

[15] *Cooperative Threat Reduction: Cooperative Threat Reduction Construction Projects;* DOD-2004-039; Department of Defense, Office of the Inspector General (Arlington, VA: December 18, 2003).

for its displaced nuclear workers through the Russian Transition Initiatives (RTI) program. The RTI program is comprised of two nonproliferation programs, the Nuclear Cities Initiative (NCI), which currently has some projects in Zheleznogorsk, and the Initiatives for Proliferation Prevention (IPP), which has a few projects in both cities. Both the NCI and IPP programs seek to prevent the proliferation of nuclear weapons knowledge from unemployed Russian nuclear weapons scientists—a problem known as "brain drain."[16] As directed by the Congress, the NCI program works in 3 of Russia's 10 closed nuclear cities: Snezhinsk, Sarov, and Zheleznogorsk. The IPP program can work in all of the closed nuclear cities. From 1999 to 2003, the NCI program spent about $15.7 million on 23 projects in Zheleznogorsk. During the same period the IPP program sponsored one project in Zheleznogorsk costing about $1.8 million and one project in Seversk that cost $1.2 million. However, NCI has not initiated any new projects since September 2003 because the government-to-government agreement guiding the program expired. The agreement has not been renewed because the United States and Russia have not agreed upon legal protections regarding liability claims that could be brought against the United States, its contractors, and their employees.

DOE's office that administers the reactor shutdown program (Office of International Nuclear Safety and Cooperation) and the DOE office that is responsible for the RTI program (Office of Nonproliferation and International Security) have begun to coordinate their efforts, which include attending regular meetings and planning for joint trips to the cities. However, as of April 2004, DOE had not developed a plan to formally coordinate the department's program to facilitate the shutdown of the reactors with the ongoing DOE efforts to help Russia find employment for its displaced nuclear workers. DOE officials from both program offices told us they are starting to draft a joint action plan to address Russian workforce transition issues related to the shutdown of the plutonium production reactors. In addition, DOE is working with Swiss officials to organize an international conference to discuss potential employment projects at Seversk and Zheleznogorsk.

[16]For more information, see U.S. General Accounting Office, *Nuclear Nonproliferation: Concerns With DOE's Efforts to Reduce the Risks Posed by Russia's Unemployed Weapons Scientists*, GAO/RCED-99-54 (Washington, D.C.: February 19, 1999) and *Nuclear Nonproliferation: DOE's Efforts to Assist Weapons Scientists in Russia's Nuclear Cities Face Challenges*, GAO-01-429 (Washington, D.C.: May 3, 2001).

Additionally, the United States and several other countries fund the International Science and Technology Center (ISTC) program.[17] This program supports science centers in Russia and Ukraine and focuses on paying nuclear, chemical, and biological weapons scientists to conduct peaceful research in a variety of areas, such as developing new anticancer drugs, improving nuclear safety, and enhancing environmental cleanup techniques. The Department of State is responsible for implementing the program on behalf of the U.S. government and chairs an interagency group that conducts a policy review of all project proposals submitted for funding. As of March 2004, ISTC had three active projects in Seversk and Zheleznogorsk. According to DOE officials, DOE has not coordinated with the ISTC program on workforce issues related to the shutdown of the plutonium production reactors. They noted that DOE views the shutdown effort as a departmental initiative although DOE plans to seek support from other countries in its efforts to find employment opportunities for displaced workers. Department of State officials told us that clearer agreement on the problem and a coordinated U.S. government approach was needed before the ISTC could be used to address worker displacement issues at Seversk and Zheleznogorsk. They also stated that they are prepared to use the ISTC program in coordination with other U.S. efforts to address the problem.

DOE Has Spent Only a Small Portion of Available Program Funds, and Total Program Costs Are Likely to Be Significantly Higher Than DOE's Original Estimates

As of December 31, 2003, DOE had spent $7.8 million, about 4 percent of the funds available, to begin work on planning and developing the program. In addition, DOE officials told us that they expect the final cost of the program to be significantly higher than their initial estimate. DOE's slow rate of spending on program activities has led to about $179.1 million in unobligated and unspent funds. Furthermore, the cost to build the replacement fossil fuel plants, which DOE had projected to be $466 million, is uncertain because the estimate is based on Russian cost projections that DOE has not yet validated. According to DOE officials, the actual construction costs for the plants are likely to be significantly higher than the original estimate, possibly as much as $1 billion. DOE and its contractors are currently revising the preliminary estimate to reflect changes in the projects' schedule and scope.

[17]For more information, see U.S. General Accounting Office, *Weapons of Mass Destruction: State Department Oversight of Science Centers Project*, GAO-01-582 (Washington, D.C.: May 10, 2001).

DOE's Slow Rate of Spending on the Program Has Led to a Large Balance of Unspent and Unobligated Funds

As of December 31, 2003, DOE had unobligated funds totaling $137.9 million and an additional $41.2 million that has been obligated, but not yet spent. Together, these funds represent DOE's total carryover balance of $179.1 million, which represent about 96 percent of the funds available for the program. As table 1 shows, through December 31, 2003, DOE had received $186.9 million in funding for the program but had only spent about $7.8 million of these available funds to begin work on planning and developing the program. Specifically, DOE indicated that these funds were mainly spent on planning and developing the program and include travel, overhead, project administration, and document translation costs.

Table 1: Obligations and Expenditures for DOE's Elimination of Weapons-Grade Plutonium Production Program through December 31, 2003

Dollars in millions

Recipient of funding	Funds available[a]	Unobligated funds	Funds obligated	Funds obligated but not spent	Funds obligated and spent
DOE/Non-project specific[b]	$139.7	$137.9	$1.8	$0.8	$1.0
National Energy Technology Laboratory	8.5	0	8.5	5.3	3.2
Pacific Northwest National Laboratory[c]	21.5	0	21.5	20.1	1.4
Washington Group International	3.9	0	3.9	2.8	1.1
Raytheon Technical Services	13.3	0	13.3	12.2	1.1
Total	**$186.9**	**$137.9**	**$49.0**	**$41.2**	**$7.8**

Source: DOE.

Note: Figures have been rounded.

[a]The total funds available for the program includes $50 million in newly appropriated fiscal year 2004 funding, but excludes any general reductions and rescissions which had not been incorporated as of December 2003.

[b]The DOE/Non-project specific category includes efforts for crosscutting activities (i.e., technical support activities) and funds available at headquarters not yet sent to the field for a specific project or task.

[c]Funds available for PNNL include $4.0 million appropriated to the International Nuclear Safety Program in a fiscal year 2002 emergency supplemental appropriation (P.L. 107-206) but supports the program objectives for the Nuclear Safety Upgrades Project. In February 2004, DOE cancelled its

planned Nuclear Safety Upgrades Project at the request of Russia. DOE is examining options for using the unspent funding for this effort in other program areas.

According to DOE officials, three major factors account for DOE's current carryover balances:

- After management of the program was transferred from DOD to DOE in December 2002, DOE received $74 million in unspent program funding from DOD. These funds were in addition to DOE's appropriations for the program.

- According to DOE and U.S. industry officials, large-scale construction projects require "front end" funding because construction projects are executed over several years. DOE officials expect the program's obligations and expenditures to increase significantly when the Seversk project moves from the design phase to the construction phase near the end of fiscal year 2004 and the Zheleznogorsk project moves into the construction phase in the second quarter of fiscal year 2005.

- Difficulties and unforeseen delays are frequently associated with doing work in Russia.

Large carryover balances are not uncommon for DOE nonproliferation programs in Russia. In March 2003, DOE reported that its nuclear nonproliferation programs had a total carryover balance of almost $460 million. DOE indicated that the large carryover amounts were due to difficulties in negotiating and executing contracts with Russia and the multiyear nature of these programs.

Despite the program's large carryover balance, DOE has requested an additional $50.1 million for the program in fiscal year 2005. Specifically, the request includes $39.5 million for the Seversk fossil fuel plant construction, about $9.6 million for the Zheleznogorsk plant, and $1 million for technical support activities. In addition, DOE's fiscal year 2005 budget projects the annual budget requests for fiscal years 2006 through 2009 to be between $56 million and $66.9 million.

Total Cost to Build the Replacement Fossil Fuel Plants May Be as Much as $1 Billion

In April 2003, DOE estimated that it would cost $466 million to build the replacement fossil fuel plants. DOE estimated that the plant at Seversk would cost about $172 million and the Zheleznogorsk plant would cost

approximately $295 million.[18] However, because DOE's estimates are based on Russian cost projections developed between 2000 and 2001, which DOE has not validated, the final cost to build the replacement fossil fuel plants is uncertain. According to DOE officials, revised cost estimates are currently being developed by DOE's contractors and are likely to be significantly higher than the original estimate, possibly totaling as much as $1 billion. For example, the original estimate did not include the costs of U.S. and Russian integrating contractors. Several other factors contributing to the projected cost increase include the high rate of inflation in Russia, higher than expected Russian labor and overhead rates, and unanticipated problems with the design plans for both plants. For example, DOE officials told us that the initial cost estimates for the Seversk plant were based on an existing Russian design for the refurbishment, which DOE believed to be at an advanced stage. However, after DOE and WGI began examining the design documents, they found that much of the design was incomplete. As a result, Russian contractors will perform additional design work, which will contribute to increased project costs. As more of the design work is completed, refined overall cost and schedule estimates will be developed for the plants. According to DOE, firm cost estimates will be provided to the Congress by the end of 2004.

DOE plans to fund the entire cost of the replacement fossil fuel plants, which will be based on a Russian design and constructed by Russian contractors. DOE, Department of State, and National Security Council (NSC) officials told us that the United States did not insist that Russia commit resources to building the plants when the March 2003 reactor shutdown agreement was signed. NSC and Department of State officials noted that the United States was concerned that Russia would not be able to fund its part of the effort, and it did not want the program to be subject to the unpredictability of the Russian budgetary process, which could delay the program. The Department of State official also noted that the U.S. government decided that the U.S. interest in pursuing the objective of the earliest possible shutdown of the reactors overrode its interest in a potentially fairer allocation of costs for building the replacement fossil fuel plants. DOE officials pointed out that Russia will be responsible for the maintenance and operation of the plants once they are completed and that Russia is sacrificing some electricity production capacity because the replacement fossil fuel plants will not produce as much electricity as the reactors. DOE considers these Russian efforts as "in-kind" contributions.

[18]DOE's cost estimates for the replacement fossil fuel plants have been rounded.

Cost increases and schedule delays are not uncommon for U.S. nonproliferation programs in Russia. For example, the United States has had difficulties with past major construction projects in Russia, such as the Chemical Weapons Disposal Facility at Shchuch'ye, and many of these projects have experienced dramatic cost increases, significant delays, or other major setbacks.[19] At Shchuch'ye, DOD is assisting Russia by building a chemical weapons destruction facility. As a result of changes in the project's scope and other factors, the estimated cost for the project increased from about $750 million to about $1.04 billion. Congressional concern over Russia's financial commitment to the project led to a congressional mandate that Russia commit at least $25 million annually toward its chemical weapons destruction activities.

Conclusions

DOE's effort to secure the shutdown of Russia's three plutonium production reactors is a critical nonproliferation program because it seeks to eliminate the production of weapons-grade plutonium. However, implementing this complex and technically challenging program is becoming an increasingly risky undertaking for DOE. Some actions that Russia has taken raise serious questions about its commitment to the nonproliferation and safety-related goals of DOE's program. We believe, as do some DOE officials, that Russia could have demonstrated good faith by reducing the amount of plutonium produced by the reactors in the period before they are shut down. This could have been accomplished by extending the amount of time the reactors are shut down for maintenance during the summer months—a proposal that Russian officials told us could be easily accomplished. However, Russia informed DOE that it had no interest in pursuing this opportunity. While Russia's unwillingness to consider this proposal represents a setback, we believe that extending the summer outage periods for the reactors furthers U.S. nonproliferation objectives and would meet an important national security goal. In addition, DOE was willing to spend over $20 million to improve the safety of these reactors, which have been characterized as being among the most unsafe reactors operating today. In this case, Russia also rejected DOE's planned assistance to improve the reactors' safety and claims that it will make its own safety improvements. We believe that the continued operation of these

[19]We reported on problems with the Shchuch'ye facility in April 1999. For more detailed information, please see U.S. General Accounting Office, *Weapons of Mass Destruction: Effort to Reduce Russian Arsenals May Cost More, Achieve Less Than Planned*, GAO/NSIAD-99-76 (Washington, D.C.: April 13, 1999).

reactors, given their current age and condition, presents a significant and growing safety risk. Without implementing DOE's proposed safety upgrades, the safety risks posed by the reactors will continue to increase dramatically.

Although the existing agreement between DOE and Russia's Ministry of Atomic Energy governing the shutdown of Russia's plutonium production reactors provides a general framework for cooperation, there are no guarantees that the reactors will be shut down within DOE's projected time frames. Furthermore, the agreement does not specify what steps must be taken to shut down the reactors and what specific requirements must be met to certify the completion of the replacement fossil fuel plants. Without defining these steps and specific requirements, DOE will be unable to develop accurate estimates for the true scope and cost of its program or be able to determine more precisely when the reactors will be shut down. The history of U.S.-Russian nonproliferation activities has demonstrated that some well-intentioned programs have had limited success because the agreements governing them lacked specificity or oversight was inadequate. The lessons of the past should be carefully considered as DOE moves forward with its program. Furthermore, the existing time frames for shutting down the reactors reflected in the agreement are neither accurate nor achievable. DOE, Department of State, and Russian officials recognize that the shutdown dates in the agreement are unrealistic and will need to be revised to reflect DOE's schedule for the completion of the fossil fuel plants. Because of the history of failed efforts to secure the reactors' closure and the inability to achieve previously agreed upon shutdown dates for these reactors, we believe it would be in the best interests of the United States to revise the agreement in order to have increased assurances that the reactors will be permanently shut down.

A major consequence of DOE's program to assist Russia's closure of the reactors will be the displacement of thousands of Russian nuclear workers who are currently employed at the reactors and related facilities. Many of these workers have received specialized training in the manufacture and reprocessing of weapons-grade nuclear material and could pose a serious proliferation risk if unemployed because they might sell sensitive nuclear information to terrorists or countries of concern. This looming problem, if left unaddressed, has the potential to undermine the program. Although DOE has started to coordinate the reactor shutdown program with the department's other efforts to employ Russian nuclear workers—specifically the Russian Transition Initiatives—it has not developed a plan to coordinate these two nonproliferation programs. Moreover, there is no

overall U.S. government strategy that would integrate the Department of State's International Science and Technology Center program with DOE's programs to employ Russian weapons scientists, particularly in the cities where the reactors will be shut down. A jointly planned effort could strengthen U.S. nonproliferation efforts by leveraging resources and expertise between these programs. Such a plan could also identify other options to support employment opportunities in the two cities, including seeking financial support from other countries.

Estimated costs to construct the replacement fossil fuel plants are expected to increase dramatically. With the total cost for the program expected to be as much as $1 billion, DOE's program has taken on greater financial risk and will require a more substantial investment of resources. Because the United States has agreed to fully fund the costs of the replacement plants, Russia has little incentive to control construction costs. Russia would be more likely to show fiscal restraint if it were responsible for funding a portion of the construction projects. In the final analysis, this program will provide Russia with significant capital assets that Russia would have had to finance itself if not for the assistance of the United States. Additionally, DOE's approximately $179 million balance of unobligated and unspent program funding raises concerns, especially in light of the department's request for an additional $50.1 million in fiscal year 2005. Although DOE officials believe that these carryover balances are justified, it is highly unlikely that DOE will be able to spend its entire available program funding by the end of fiscal year 2004 because construction at both plants is not expected to begin until at least fiscal year 2005.

Recommendations for Executive Action

To help achieve important U.S. nonproliferation objectives, we recommend that the Secretary of Energy and the Administrator of the National Nuclear Security Administration continue efforts to reduce the amount of plutonium produced by the reactors as an interim measure before they are permanently shut down. Specifically, the Secretary and the Administrator should continue to pursue the option of extending summer outage periods at the reactors as a way to realize the immediate nonproliferation benefits of reduced plutonium production in Russia.

To increase the chances for program success by clarifying the existing reactor shutdown agreement, we recommend that the Secretary of Energy, working with the Administrator of the National Nuclear Security Administration and Secretary of State, do the following:

- reach agreement with Russia on the steps that must be taken to permanently shut down the reactors and the specific requirements that must be met to complete the replacement fossil fuel plants;

- identify any additional costs that may surface as a result of refining the scope of work associated with shutting down the reactors and completing the replacement fossil fuel plants and revise cost and schedule estimates for the program accordingly; and

- amend the March 2003 reactor shutdown agreement as soon as practicable to accurately reflect DOE's more realistic shutdown dates for Russia's three plutonium production reactors.

To maximize the benefits of related U.S. nonproliferation efforts, we recommend that the Secretary of Energy and the Administrator of the National Nuclear Security Administration do the following:

- Create a specific plan and take steps to formally coordinate DOE's program to assist Russia's closure of the three plutonium production reactors with the department's efforts to find jobs for displaced Russian nuclear workers through the Russian Transition Initiatives. Such a plan should be coordinated with Russia and should include strategies for obtaining assistance from other countries in finding employment for these workers.

- Take the lead in developing a comprehensive plan that focuses on integrating U.S. efforts to employ Russian nuclear workers in the cities of Seversk and Zheleznogorsk. The plan should be developed in conjunction with the Secretary of State. Such a plan should consider ways to better ensure that future projects funded by DOE and the Department of State in Seversk and Zheleznogorsk are clearly focused on finding jobs for Russian workers who will be displaced once the plutonium production reactors and related facilities are closed.

To help defray the escalating costs of DOE's program to shut down Russia's plutonium production reactors, we recommend that the Secretary of Energy and the Administrator of the National Nuclear Security Administration consider seeking financial support from Russia to construct the replacement fossil fuel plants. To the extent possible, these contributions should not be limited to in-kind contributions such as building materials, labor, or the value of land.

To address concerns about large carryover balances of program funding, we recommend that the Secretary of Energy and the Administrator of the National Nuclear Security Administration

- monitor funding requirements to ensure that funds are obligated in a timely manner and
- determine whether future funding requirements need to be reduced in light of the slow rate of spending to date on the program.

Agency Comments and Our Evaluation

We provided the Departments of Energy and State with draft copies of this report for their review and comments. DOE's and State's written comments are presented as appendixes IX and X, respectively.

DOE's National Nuclear Security Administration said the draft report provided a balanced evaluation of its program to shut down Russia's three plutonium production reactors. DOE agreed to implement our recommendations. The Department of State agreed with all of our recommendations except one that DOE should consider seeking financial support from Russia to construct the replacement fossil fuel plants. DOE also expressed concern with our conclusion regarding this matter. Both agencies stated that relying on Russia to fund critical program elements would delay the program, something they did not want to risk. These concerns notwithstanding, we continue to believe that DOE should look for opportunities to have Russia fund a portion of the construction projects as a way to contain costs, which are expected to increase dramatically. DOE plans to pursue obtaining financial support from Russia provided that it does not delay the program. We agree with this approach.

Both agencies also disagreed with our conclusion that Russia's rejection of key initiatives to reduce the amount of plutonium produced by the reactors and to improve their safety before they are shut down signals Russia's lack of commitment to the nonproliferation and safety goals of the program. Both agencies stated that Russia rejected these initiatives primarily due to its security concerns about granting U.S. officials access to the reactors. In our report, we recognized that Russia's security concerns may have played a role in rejecting the extension of summer outages at the reactors as an option for reducing plutonium production. However, in a November 2003 letter from MINATOM to DOE, Russia did not cite security concerns as a reason for rejecting the proposal. In fact, as we noted in the report, MINATOM stated that "[Russia does] not find it worthwhile to waste efforts

on a project for reducing plutonium production prior to the permanent shutdown of the reactors." Instead, MINATOM claimed that it wanted to focus on the earliest possible shutdown of the reactors. As we noted in our report, both U.S. and Russian officials told us that extending summer outages to reduce the current production of weapons-grade plutonium held great promise and would be an easy option to implement. Furthermore, in its comments, DOE stated that it was disappointed in Russia's rejection of the proposal to study ways to reduce the amount of plutonium produced by the reactors as an interim step before they are shut down.

Regardless of Russia's basis for rejecting the proposal, it should be noted that the long-standing and ultimate U.S. goal of this program is to reduce and eliminate the production of weapons-grade plutonium in Russia as quickly as possible. From the U.S. perspective, shutting down these reactors is a major nonproliferation objective, and the United States is committing significant resources to this effort. Thus, it seems reasonable to us that Russia should reciprocate and show its commitment to the fundamental nonproliferation tenets of this program. Finally, although DOE and State objected to our characterization of the implications of Russia's decision to reject key DOE initiatives, both agencies agreed with our recommendation that seeking summer outages as a way to reduce plutonium production should continue to be pursued.

With regard to the reactors' safety, we noted in the report that they are among the most unsafe in the world and that DOE was prepared to provide a substantial amount of assistance to improve their safety. Russia's rejection of the assistance, regardless of the reasons, raises serious concerns about its commitment to ensuring the reactors' safe operation until they can be shut down. As we noted in the report, DOE and national laboratory officials expressed doubt about whether Russia would perform sufficient safety upgrades on its own.

State also objected to what it believed to be our conclusion that final shutdown of the reactors is uncertain because the reactor shutdown and implementing agreements are insufficiently clear regarding the steps to permanently and irreversibly shut down the reactors. We believe that State in its written response to our draft report has mischaracterized our conclusion. Specifically, our report cites the lack of clarity in the agreement as one of several challenges that DOE faces that could affect final shutdown. While State disagreed with our conclusion, it agreed with our recommendation that DOE should reach agreement with Russia on the steps that must be taken to shut down the reactors and the specific

requirements needed to certify the completion of the fossil fuel plants. State also believes that we overstated the implications of the agreement's lack of accurate shutdown dates. However, State acknowledged that the deadlines for reactor shutdown in the agreement are no longer consistent with current plans and agreed with our recommendation to revise the dates.

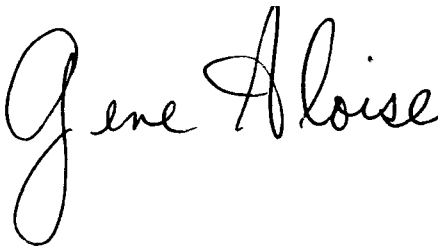
State also disagreed with our conclusion that worker transition issues have the potential to undermine the program. However, as we noted in our report, Russian officials we spoke with considered the employment of displaced workers as their highest priority and DOE officials acknowledged this as a major concern. Furthermore, DOE and State agreed with our recommendations to address this problem.

DOE and State also provided technical comments, which we incorporated in the report where appropriate.

We are sending copies of this report to the Secretary of Energy; the Administrator, National Nuclear Security Administration; the Secretary of State; 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 concerning this report, I can be reached at 202-512-3841 or aloisee@gao.gov. Major contributors to this report are included in appendix XI.

Sincerely yours,



Gene Aloise
Acting Director, Natural Resources and Environment

Information About Seversk and Zheleznogorsk

This appendix provides information about the cities of Seversk and Zheleznogorsk, the two cities in Russia where the plutonium production reactors are located.

Seversk

Formerly known as Tomsk-7, the closed city of Seversk is located approximately 2,000 miles east of Moscow and about 9 miles northwest of Tomsk, a major industrial city in western Siberia. As of January 2000, the city had approximately 119,000 residents. In addition to plutonium production, a number of other nuclear related activities have been carried out in Seversk, including the fabrication of uranium and plutonium weapons components. Recently, Seversk was selected to be the site for a planned facility that will dispose of 34 metric tons of Russia's weapons-grade plutonium by converting it into mixed oxide fuel. The planned conversion facility will be built with Department of Energy funding. Nonnuclear activities at the city include an oil refinery operation.

Seversk is the location of the Siberian Chemical Combine, which is responsible for operating the plutonium production reactors. Construction of the Siberian Chemical Combine facilities began in 1949; and on July 26, 1953, the first output of enriched uranium-235 was produced. Since its inception, the Siberian Chemical Combine has housed the Siberian Atomic Power Station; a chemical separation plant; facilities for plutonium processing, blending, and pit fabrication; an enrichment plant; and nuclear waste management facilities. The first of the plutonium production reactors at Seversk came online in 1955, and by the 1970s five such reactors were operating at the site. Three of the reactors were shut down in the early 1990s. The city's two remaining weapons-grade plutonium production reactors began operation in 1965 and 1968 and continue to provide heat and electricity to Seversk and the neighboring city of Tomsk. Currently, the Siberian Chemical Combine employs about 15,000 workers, most of whom are highly skilled nuclear experts.

Zheleznogorsk

Zheleznogorsk is located approximately 2,500 miles east of Moscow and about 35 miles north of the city of Krasnoyarsk. As of early 2000, the city had a population of 103,000. Formerly known as Krasnoyarsk-26, the city was built to house the employees of the Mining and Chemical Combine, a complex engaged in producing and processing weapons-grade plutonium. Both the city and the Mining and Chemical Combine are located on the east bank of the Yenisei River in Siberia. In 1996, the residents of Zheleznogorsk

voted to remain a closed city in an attempt to maintain the clean, village-like quality amidst harsher, more environmentally damaged towns. Since the end of the Cold War, the technical workforce in Zheleznogorsk has dropped; and the city is now in difficult financial straits. Zheleznogorsk has tried to diversify its economy through forays into satellite building and television assembly.

The three plutonium production reactors operated by the Mining and Chemical Combine were built in a huge cavern approximately 250 meters beneath a mountain. Over 60,000 prisoners were forced to excavate the chambers containing the reactors when work began in 1950, but in 1953 over 100,000 military construction workers replaced these prisoners. Two of the reactors began operating in 1958 and 1961 but were both shut down in 1992. A third plutonium production reactor, active since 1964, still functions to provide heat and electricity to the city. The Mining and Chemical Combine currently employs about 9,500 workers who in addition to plutonium production are involved in other nuclear-related activities, including the stockpiling of plutonium.

Scope and Methodology

We performed our review of DOE's Elimination of Weapons-Grade Plutonium Production program at DOE's offices in Germantown, Maryland; DOE headquarters in Washington, D.C.; the Defense Threat Reduction Agency in Ft. Belvoir, Virginia; the Department of State (State) in Washington, D.C.; the National Security Council in Washington, D.C.; the Nuclear Regulatory Commission in Rockville, Maryland; and Moscow, Seversk, and Zheleznogorsk, Russia.

To assess the progress of DOE's recent efforts to shut down Russia's three remaining plutonium production reactors, we reviewed documents and had discussions with officials from the Department of Defense (DOD); DOE; State; the National Security Council; the Nuclear Regulatory Commission; the Pacific Northwest National Laboratory (PNNL); the National Energy Technology Laboratory; the U.S. Trade and Development Agency; DOE's U.S. contractors—Washington Group International (WGI) and Raytheon Technical Services (Raytheon); and a number of nongovernmental entities, including nonproliferation and fossil fuel experts. In September 2003, we visited Russia to interview Russian officials and to see the sites for the replacement fossil fuel plants DOE plans to fund. While in Moscow, we spoke with officials from the Ministry of Atomic Energy of the Russian Federation; Rosatomstroi; the Kurchatov Institute, a leading Russian nuclear design institute; and Gosatomnadzor, the Russian nuclear regulatory agency. These officials provided Russia's views of DOE's program to build replacement fossil fuel plants and its efforts to shut down the reactors. We visited Zheleznogorsk and spoke with officials from the Mining and Chemical Combine, the city government, the planned fossil fuel plant, and the operators of the reactor. We toured the site of the planned fossil fuel plant and observed the current condition of the buildings at the site. We visited Seversk and interviewed officials from the Siberian Chemical Combine, the city government, operators of the reactors, and operators of the existing fossil fuel plant that DOE plans to refurbish. We toured the site of the existing fossil fuel plant and observed its current condition.

To assess DOE's management of the program we examined documents from DOE and DOE's U.S. contractors—WGI and Raytheon. We interviewed officials from DOE's Office of Engineering and Construction Management and from the Elimination of Weapons-Grade Plutonium Production program. In addition, while in Russia, we obtained views on DOE's management of the program from a number of Russian officials from the Ministry of Atomic Energy of the Russian Federation; Rosatomstroi; the Kurchatov Institute; Gosatomnadzor; the Mining and Chemical Combine;

the Siberian Chemical Combine; and the city governments of Zheleznogorsk and Seversk.

To identify challenges DOE faces in implementing its program, we examined documents from DOE, the Nuclear Regulatory Commission, PNNL, the National Energy Technology Laboratory, DOE's U.S. contractors—WGI and Raytheon, and several nongovernmental entities including nonproliferation and fossil fuel experts. To describe the proposed upgrades DOE planned to fund to improve the safety of the reactors while replacement fossil fuel plants were being built, we reviewed documents from DOE, the Nuclear Regulatory Commission, and PNNL. We also interviewed nuclear safety officials from DOE, the Nuclear Regulatory Commission, the Department of State, and PNNL.

To determine the amount of money spent on U.S. efforts to eliminate weapons-grade plutonium production in Russia prior to the program's transfer from DOD to DOE in December 2002, we analyzed documents and spoke with officials from DOE, DOD, the Department of State's Nonproliferation and Disarmament Fund, the U.S. Trade and Development Agency, PNNL, and the Nuclear Regulatory Commission. Dollar amounts for the historical spending on these efforts were adjusted to constant fiscal year 2003 dollars to reflect trends in inflation over time. Because they are being used for background purposes only, we did not assess the reliability of these historical data.

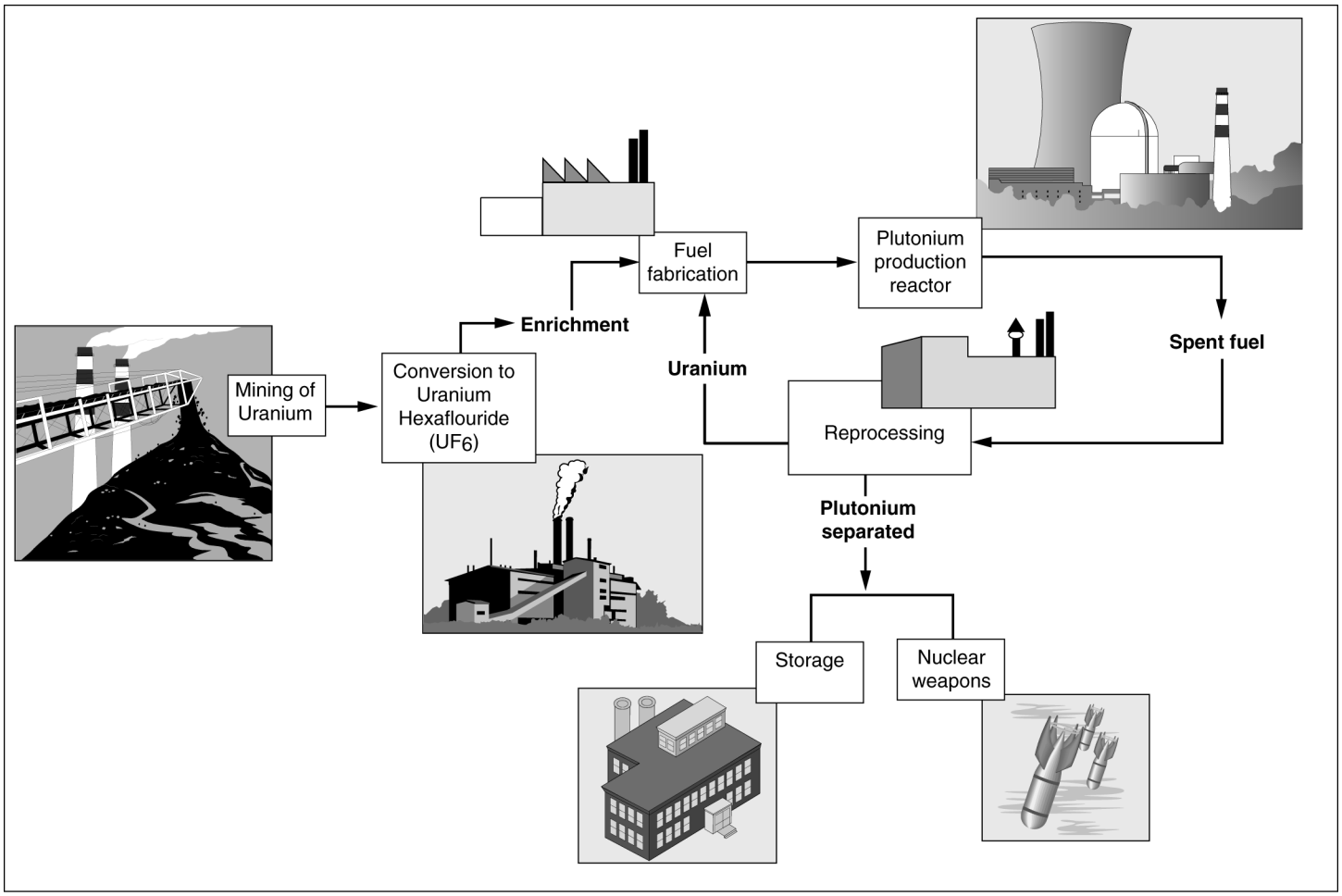
To determine how much DOE had spent through December 31, 2003 on its efforts to eliminate weapons-grade plutonium production in Russia and DOE's projected costs to implement the program, we reviewed DOE's cost and schedule estimates for the replacement fossil fuel plants, interviewed appropriate agency officials, and posed a number questions to DOE to determine the reliability of the financial data provided to us. We determined that the data were sufficiently reliable for the purposes of this report based on work we performed to assure the data's reliability. Specifically, we (1) met numerous times with program officials to discuss these data in detail; (2) obtained from key database officials responses to a series of questions focused on data reliability covering issues such as data entry access, internal control procedures, and the accuracy and completeness of the data; and (3) added follow-up questions whenever necessary.

We conducted our review between June 2003 and April 2004 in accordance with generally accepted government auditing standards.

The Plutonium Production Nuclear Fuel Cycle

Plutonium is a byproduct of the nuclear fuel cycle and is produced by all nuclear reactors. Weapons-grade plutonium, however, contains a high content of plutonium-239, which is the most suitable isotope for use in nuclear weapons. Plutonium of this type is formed in the Russian production reactors as a component of highly radioactive spent reactor fuel. Although at this point the plutonium is relatively protected against proliferation because it is diluted and surrounded by the highly radioactive spent fuel, it cannot be safely stored for long periods in this form at the "wet storage" areas at the reactors to preclude corrosion and cracking in the aluminum fuel cladding. The plutonium is taken to another facility where it is chemically separated from the spent fuel in an operation called "reprocessing." There is also an optimal time to reprocess the spent nuclear fuel: reprocess too soon and the fuel is highly radioactive, reprocess too late and the fuel can contaminate the spent fuel pool. Although the reprocessed fuel requires containment and is easily incorporated into weapons, it is also relatively easier and less expensive to store than spent fuel. Figure 3 illustrates the plutonium production cycle.

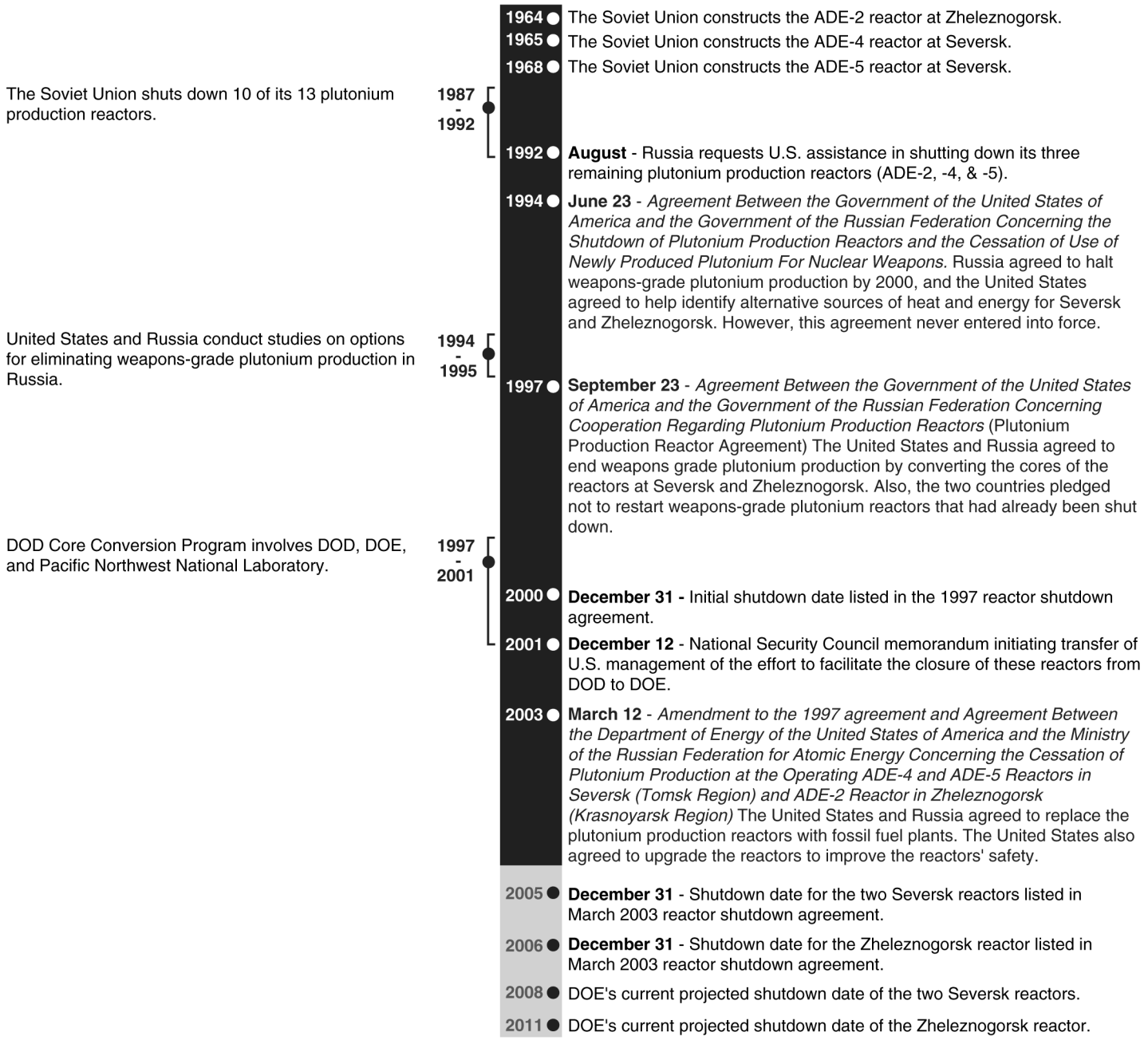
Figure 3: Nuclear Fuel Cycle Resulting in the Production of Weapons-Grade Plutonium



Sources: GAO; Nova Development (clip art).

Time Line Showing the History of Russia's Remaining Plutonium Production Reactors and Efforts to Bring About Closure

Figure 4: Russian Plutonium Production Reactor Time Line



Source: GAO.

Additional Information About DOE's Management Plan for the Program

Figure 5 shows the project acquisition process and critical decision (CD) points used in the DOE order 413.3 program management structure, which DOE has adopted for the program.

Figure 5: DOE Order 413.3 Project Acquisition Process and Critical Decisions

Project Acquisition Process and Critical Decisions				
Project planning phase		Project execution phase		Mission
Preconceptual planning	Conceptual planning	Preliminary design	Final design	Construction	Operations
CD-0 Approve mission need	CD-1 Approve preliminary baseline range	CD-2 Approve performance baseline	CD-3 Approve start of construction	CD-4 Approve start of operations or project closeout	

CD-0	CD-1	CD-2	CD-3	CD-4
Actions authorized by Critical Decision approval				
• Proceed with conceptual design using program funds	• Allow expenditure of funds for design	• Establish baseline budget for construction • Continue design • Request construction funding	• Approve expenditure of funds for construction	• Allow start of operations or project closeout
Critical Decision prerequisites				
• Justification of mission need document • Acquisition strategy • Preconceptual planning • Mission need independent project review	• Acquisition plan • Conceptual design • Preliminary project execution plan and baseline range • Project data sheet for design • Verification of mission need • Preliminary hazard analysis report	• Preliminary design Review of contractor project management system • Final project execution plan and performance baseline • Independent cost estimate • National environmental policy act documentation • Project data sheet for construction • Draft preliminary safety analysis report • Performance baseline external independent review	• Update project execution plan and performance baseline • Final design and procurement packages[a] • Verification of mission need • Budget and congressional authorization and appropriation enacted • Approval of safety documentation • Execution readiness independent review • Operational readiness review and acceptance report • Project transition to operations report • Final safety analysis report	**Closeout** • Project closeout report

Source: DOE.

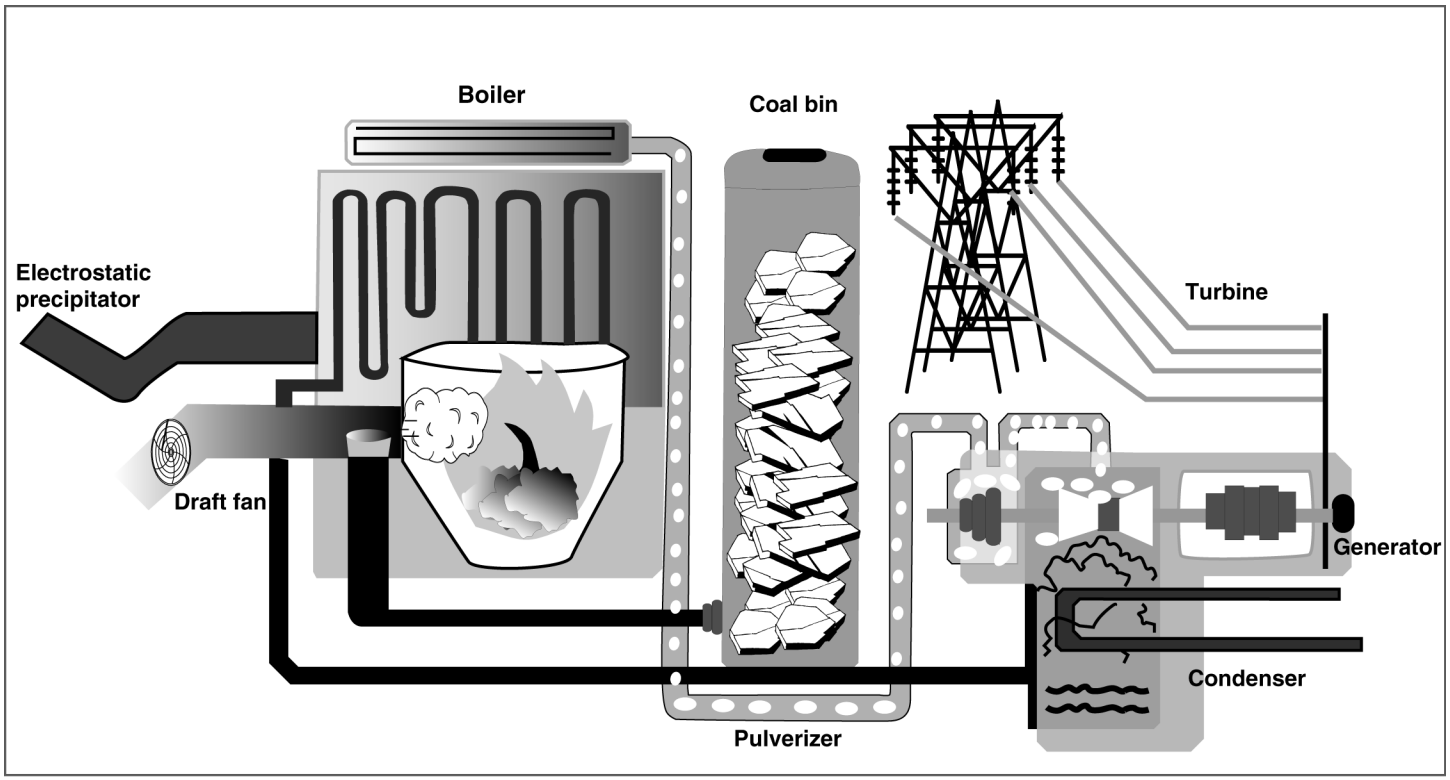
[a]To the degree appropriate to initiate construction as scheduled.

As figure 5 shows, the five CD points are: (1) CD-0, approve mission need; (2) CD-1, approve preliminary baseline range; (3) CD-2, approve performance baseline; (4) CD-3, approve start of construction; and (5) CD-4, approve start of operation or project closeout. Figure 5 also shows the prerequisite documentation and project milestones, such as the acquisition and project execution plans, which must be provided before critical decision approval can be granted. DOE officials believe that this management approach will help improve program oversight and accountability. The fossil fuel plant construction projects at Seversk and Zheleznogorsk gained approval of mission need (CD-0) from the Deputy Secretary of Energy in December 2002. DOE officials told us that the Seversk project would proceed to CD-1 in April/May 2004 and to CD-2 near the end of fiscal year 2004. The Zheleznogorsk project is expected to move to CD-1 in August 2004 and to CD-2 in the second quarter of fiscal year 2005.

Description of a Coal-Fired Power Plant

This appendix describes how electricity and heat are produced by a coal-fired power plant. Although the plant described is not identical to ones that will be constructed in Russia, the description is generic and can generally be applied to all coal-fired power plants. Figure 6 shows how electricity is produced by a coal-fired power plant.

Figure 6: Coal-Fired Power Plant



Sources: Pepco; Nova Development (clip art).

Coal is pulverized into a fine powder as it leaves the coal bin. That powder is blown into a boiler where it is ignited. The walls of the boiler contain miles of tubing, through which water is circulated. Heat from the burning coal turns the water into steam. The steam passes through piping to a turbine. The steam is directed against blades of the turbine causing it to spin. The turbine shaft turns, rotating the generator, which creates electricity. After the steam is directed against the blades, it goes to a condenser beneath the turbine. Cool water in the condenser turns the

steam back into water. The water is pumped back into the boiler tubes to be heated into steam again. Large fans blow air into the boiler to support the combustion of coal. Some of the air is directed to the pulverizer where it helps dry the coal and carry it to the boiler. Coal ash drops to the bottom of the boiler for disposal. Hot gases escape from inside the boiler. Impurities are removed from these gases through scrubbing systems before they are released through the stack.

Description of DOE's Planned Nuclear Safety Upgrades

As part of the March 2003 reactor shutdown agreement signed by DOE and the Ministry of Atomic Energy of the Russian Federation, DOE pledged to improve the safe operation of Russia's three remaining plutonium production reactors until they can be shut down. Prior to Russia's decision to reject DOE assistance to improve the safety of the reactors, DOE had allocated $21 million to support 28 safety upgrade projects including fire safety system improvements, enhancements to emergency electrical power systems, and risk assessments. DOE planned to complete the safety upgrades within 24 months in order to improve the safety of the reactors during their remaining lifetime. To oversee the safety upgrade projects, DOE selected PNNL, which had managed prior efforts under DOD to modify the reactors' cores and was thus familiar with the reactors and their design and safety problems.

DOE selected the safety upgrade projects after determining that none of them would extend the operating life of the reactors. DOE chose the 28 projects out of a larger list of 40 projects that Russian reactor officials submitted. According to DOE and PNNL officials, some of the reactor upgrades that Russia initially proposed were rejected because they were potentially life extending or would require too much time to implement. For example, DOE rejected Russian upgrades to improve the primary coolant pipes of the reactors due to concerns that such improvements would be life extending.

Table 2 provides information about each of DOE's planned upgrades to improve the safety of Russia's three plutonium production reactors.

Table 2: DOE's Planned Nuclear Safety Upgrade Projects

Dollars in thousands

Project name	Location	Estimated cost	Responsible Russian organization	Project description
Control and Protection System	Zheleznogorsk ADE-2[a]	$1,090	Mining and Chemical Combine	Upgrade the sensors and scram logic for the Control and Protection System to improve the scram reliability upon demand
Emergency Electrical Power Supply	Zheleznogorsk ADE-2	650	Mining and Chemical Combine	Improve reliability of the Emergency Electrical Power Supply System by replacing aging batteries
Graphite Stack Stabilization	Zheleznogorsk ADE-2	1,290	Mining and Chemical Combine	Stabilize graphite stack by ensuring the control rods will insert rapidly during a scram
Strain Gauge Monitoring System	Zheleznogorsk ADE-2	520	Mining and Chemical Combine	Add a strain gauge monitoring system to fuel channel connections (or "goose necks") to ensure against progressive degradation in selected primary system components
Fire protection for Emergency Electrical Power Supply	Zheleznogorsk ADE-2	970	Mining and Chemical Combine	Improve reliability Emergency Electrical Power Supply System by replacing deteriorating electrical insulation
Safety Analysis Report chapter 4 and system reliability	Zheleznogorsk ADE-2	410	OKBM	Perform accident analysis on the upgraded reactor plant as required for a Safety Analysis Report
Safety Analysis Report additional chapters	Zheleznogorsk ADE-2	500	OKBM	Develop other Safety Analysis Report chapters to obtain a complete report for the upgraded plant
Emergency communications	Zheleznogorsk ADE-2	390	Mining and Chemical Combine	Replace obsolete emergency communications equipment with a modern system capable of reliably functioning in the event of an accident
Emergency Core Cooling System	Seversk ADE-4	900	Kurchatov Institute & OKBM	Improve the response of the Emergency Core Cooling System by allowing rapid access to the emergency water inventory and by properly allocating this inventory in the event of a loss of coolant accident
Subcritical Reactivity Monitoring System	Seversk ADE-4	640	Siberian Chemical Combine & Kurchatov Institute	Install a subcritical reactivity monitoring system to monitor subcritical reactivity of reactor during refueling outages to prevent unplanned reactor power additions
Safety Analysis Report chapter 4	Seversk ADE-4 and ADE-5	260	OKBM	Perform accident analysis on the upgraded reactor plant as required for a Safety Analysis Report

(Continued From Previous Page)

Dollars in thousands

Project name	Location	Estimated cost	Responsible Russian organization	Project description
Safety Analysis Report additional chapters	Seversk ADE-4 and ADE-5	510	OKBM	Develop Safety Analysis Report chapters to obtain a complete report for the upgraded plant
Probabilistic Risk Assessment	Zheleznogorsk ADE-2	310	OKBM	Modify Probabilistic Risk Assessment to reflect the reactor plant with safety upgrades
Probabilistic Risk Assessment	Seversk ADE-4 and ADE-5	310	OKBM	Modify Probabilistic Risk Assessment to reflect the reactor plant with safety upgrades
Safety Code Verification Testing	All three reactors (ADE-2, ADE-4, & ADE-5)	710	OKBM	Perform cold experiments to benchmark safety codes on the actual configurations that will be found in accidents
Safety Computer Codes	All three reactors (ADE-2, ADE-4, & ADE-5)	390	OKBM	Obtain modern codes and employ them in accident analyses required for chapter 4 of the Safety Analysis Report
Emergency Core Cooling System Valve Replacement and Loop Separation	Seversk ADE-4	2,320	Siberian Chemical Combine	Upgrade reactor-cooling systems to reduce vulnerability to loss of coolant accidents resulting from major boundary failures
Emergency Core Cooling System Equipment Procurement	Seversk ADE-5	900	Siberian Chemical Combine	Procure equipment needed for upgrade of Emergency Core Cooling System of ADE-5
Emergency Electrical Power Supply	Seversk ADE-4 and ADE-5	610	Siberian Chemical Combine	Improve reliability of the Emergency Electrical Power Supply System by replacing aging batteries and eliminating accident-prone environments
Control and Protection System	Seversk ADE-4 and ADE-5	770	Siberian Chemical Combine	Improve the reliability of the control and protection system to allow more reliable detection of over-power transients
Fire Protection for Emergency Electrical Power Supply	Seversk ADE-4 and ADE-5	640	Siberian Chemical Combine	Improve the reliability of the Emergency Electrical Power Supply System by replacing deteriorating electrical insulation
Passive Protection Systems	Seversk ADE-4 and ADE-5	320	Siberian Chemical Combine	Verify the performance of passive protection devices to ensure that they will function as required in an accident situation
Accident Management Manuals	Seversk ADE-4 and ADE-5	340	Siberian Chemical Combine	Upgrade Accident Management Manuals to improve operator response
Process Ventilation System	Seversk ADE-4 and ADE-5	2,830	Siberian Chemical Combine	Upgrade Process Ventilation System so that it has the capacity to retain airborne fission products in the event of fuel melting and multiple fuel channel ruptures

(Continued From Previous Page)

Dollars in thousands

Project name	Location	Estimated cost	Responsible Russian organization	Project description
Emergency communications	Seversk ADE-4 and ADE-5	250	Siberian Chemical Combine	Replace obsolete emergency communications equipment with a modern system capable of reliably functioning in the event of an accident
Ejected fuel element shielding removal	Seversk ADE-4 and ADE-5	260	Siberian Chemical Combine	Remove iron shot used to cover four ejected fuel elements from a 1999 fuel loading accident
Emergency Core Cooling System review	Seversk ADE-4 and ADE-5	130	Siberian Chemical Combine	Review the design and operation of the N-Reactor Emergency Core Cooling System to develop insights into preferred operating approaches
Accident Management Manuals	Zheleznogorsk ADE-2	290	Mining and Chemical Combine	Upgrade Accident Management Manuals to improve operator response
Accident Steam Dump System	Zheleznogorsk ADE-2	1,800	Mining and Chemical Combine	Upgrade system to increase capacity of steam rejection system to ensure against steam over-pressures and mechanical damage to primary piping under accident conditions

Source: DOE.

[a]The Russian acronym used to identify the three remaining plutonium production reactors is "ADE." ADE-2 refers to the reactor at Zheleznogorsk and ADE-4 and ADE-5 refer to the reactors at Seversk.

GAO Technical Analysis of the Safety Problems Associated with Russia's Three Plutonium Production Reactors

Russia's three remaining weapons-grade plutonium production reactors are among the most dangerous reactors currently operating in the world. All three of the reactors were built using old designs derived from the original reactor run by Enrico Fermi in the 1940s. According to officials from MINATOM, the Russian nuclear regulatory agency Gosatomnadzor, and the Kurchatov Institute—the leading civilian nuclear research institute in Russia—the reactors must be shut down by 2010.[1] However, the reactor managers at Seversk believed that the continuous repairs to the reactors over the years are increasing the operating life and that further safety upgrades could allow the reactors to operate until 2014. In our view, all three reactors are showing the wear of having been run for a very long time at very high output, and all have had accidents—some as recently as 5 years ago.

The safety risks posed by these reactors are a function of three factors: (1) all three reactors have been running at a very high output, producing both high temperatures and high neutron flux (the number of neutrons passing through a sphere one square-centimeter in cross-section during a unit of time) for their entire lives; (2) all three reactors have run approximately twice as long as they were originally designed to operate; and (3) none of these reactors meet current reactor safety standards. The danger that these reactors present is the risk of a catastrophic reactor failure—such as a loss of coolant accident—which would result in a fire expelling the highly enriched uranium fuel and its fission byproducts such as plutonium and strontium-90, all of which are highly toxic and carcinogenic. The danger from such a fire is that radioactive particles would be dispersed and breathed into the body, causing either kidney damage from particles of uranium or cancer from particles of strontium-90 and plutonium.

All three reactors are designed to run at rated power, which is the original power output level of a reactor in terms of temperature output (t), and electrical output (e). According to Gosatomnadzor, the rating for the reactors is 800 megawatts (t) each. A Gosatomnadzor official informed us that the reactors could run at 20 percent higher than their original rating, or at 960 megawatts (t), and that the reactors had run at an elevated level during a 20-year period. In our opinion, Gosatomnadzor's estimates are probably conservative because, based on the amount of fuel that can be used by the reactors and the fuel type that has been used, each reactor has

[1]DOE officials believe that the 2010 date is administrative and provided documentation that indicated the reactors could operate until 2024.

the ability to run at a power level up to 2,500 megawatts (t) and has been run at a power level of at least 2,000 megawatts. If these reactors were originally designed to run at 800 megawatts (t), then they may have run at three times their original design rating. This will definitely shorten the operating life of the reactors, which makes their continued operation risky.

Russian officials that we met disagree over both the original life spans of the reactors and how much longer the reactors can be operated before the risk of a catastrophic failure becomes too high. According to officials from MINATOM, Gosatomnadzor, and the Kurchatov Institute, the original life span for each of the reactors was 25 years. However, according to the operators of the three Russian reactors, the original reactor life spans are 20 years. All three reactors have operated for approximately 40 years, or roughly twice as long as originally designed. Gosatomnadzor confirmed that the design life is a function of: (1) the graphite cladding—which forms the outer, protective layer of the fuel elements and (2) the steel containment that surrounds the core. If it is assumed that the reactors have operated at 2,500 megawatts (t) for 20 years, then the original design life of 20 years could be reduced by up to 10 years, since the super heating of the graphite and the high neutron flux at the core center will cause much higher degradation than if the reactors were run at their rated power levels for their entire lives. These two factors will make the integrity of both the graphite cladding and the steel containment highly questionable and will increase the risk of a catastrophic failure of the reactors.

None of the reactors meets current Russian, U.S., or international safety standards because they lack modern safety controls and are therefore dependent on direct operator intervention for both monitoring and safety. MINATOM, Gosatomnadzor, and the Kurchatov Institute told us that the personnel working at the reactors pose a safety threat because the quality of the reactor staff is weakening due to attrition and old age. According to Gosatomnadzor, the average age of reactor workers is 50, and the reactors are experiencing an increased number of temporary emergency shutdowns due to operator error, not the technology itself. Conversely, reactor officials at Seversk were concerned that the attrition of older workers will result in the loss of the knowledge and the ability of people that have become familiar with the reactors over many years. Although the Russian organizations disagree over the cause of the increased rate of accidents, there is a consensus that workforce attrition will have an impact on the safe operation of the reactors because it is likely that the reactor workers are the first and last line of defense against reactor accidents.

Comments from the Department of Energy

Department of Energy
National Nuclear Security Administration
Washington, DC 20585

MAY 1 3 2004

Mr. Gene Aloise
Acting Director
Natural Resources and Environment
General Accounting Office
441 G St, NW
Washington, D.C. 20548

Dear Mr. Aloise:

The National Nuclear Security Administration (NNSA) appreciates the opportunity to have reviewed the General Accounting Office's (GAO) draft report, "NUCLEAR NONPROLIFERATION: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain." We understand that the Chairman, Subcommittee on Emerging Threats and Capabilities, Senate Committee on Armed Services, requested GAO to (1) determine what progress has been made toward achieving the goal of shutting down these reactors and assess if the dates for the planned shut down are achievable and realistic; (2) determine what obstacles the program faces that could delay the implementation and completion of the program and what measures the NNSA plans to use to address such obstacles; (3) assess the budget, management, planning and implementation of the program; and (4) assess the extent to which any safety upgrades provided by NNSA for these reactors may prolong their life, thereby possibly delaying their shut down.

Based on your work you have concluded that we should reach agreement with the Russians on the steps that must be taken to permanently shut down the reactors and the conditions necessary to complete the fossil fuel plants; amend the reactor shutdown agreement to reflect our revised completion dates for the fossil fuel plants; and to develop a plan in conjunction with the Russians, to address the problem of employing nuclear workers who will lose their jobs when the reactors are closed.

The Department agrees with several of the recommendations and is moving forward with implementation. We are starting work with the Russians on a Reactor Shutdown Plan, which will tie Russian steps toward permanent shutdown of the three remaining plutonium production reactors to specific milestones in the construction of the fossil fuel replacement plants. Another action is working both internally and with potential international partners to address the concern about displaced workers. At Seversk, the

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situation is particularly acute in that actions may need to start as early as next year if the Russians agree to an early shutdown of one of the Seversk reactors once a mutually agreed stage of construction is reached. Please be aware also that Ambassador Brooks is putting pressure on all programs within the National Nuclear Security Administration to reduce uncosted balances. If events proceed as planned, major construction should begin at Seversk in FY 2005. This would allow us to obligate and begin costing a significant portion of the Project's remaining funds. However, I do caution that, in order for the Project to move forward on the aggressive schedule planned, the requested funding needs to be provided by Congress.

There are two major points where we disagree with the position stated in the draft Report and request that you consider our concerns during your final reviews. The first point is the conclusion reached that Russia's reluctance to consider extending the summer outage to reduce plutonium production and their assumption of the responsibility for the nuclear safety upgrades calls into question their commitment to non-proliferation. As you will see in our enclosed detailed comments, we do not share this view. In fact, a cogent argument can be made to draw the opposite conclusion. They did not want to consider the extended summer option because they thought it would detract from the effort to complete the fossil construction and resulting reactor shutdown as soon as possible. They also are still holding out the possibility that one reactor at Seversk may be shutdown early as referenced above. We see the Russian assumption of the nuclear safety work with mixed emotions. On the one hand, I am confident that our experts would have provided upgrades of known quality and capability. On the other hand, your Report argues for more Russian contributions to the Project and this is such an effort on their part. Their assumption of this work will not impact the fossil construction schedule.

Our other concern, that we should seek further Russian cost sharing, is a concern, particularly if it is in areas, which have schedule implications. One of their contributions is the Zheleznogorsk site. As your Report notes, this was a long, difficult process, which caused delays for our side. We are also concerned that we cannot delay the schedule on this critical nonproliferation project while negotiating and awaiting cash contributions for the program. While we will explore this consideration, we will also evaluate the risk of this alternative to the schedule adherence and overall cost effectiveness for the U.S. tax payer.

As stated, we have enclosed detailed comments related to this draft report. Technical questions may be answered by Dr. James Turner or Mr. Kenneth Chancey.

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

Sincerely,

Michael C. Kane
Associate Administrator
for Management and Administration

Enclosure

cc: Deputy Administrator for Defense Nuclear Nonproliferation, NA-20

NNSA's Comments on
GAO Draft Report;
NUCLEAR NONPROLIFERATION: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown is Uncertain
(GAO-04-662)

In summary, DOE finds the draft report to be a balanced evaluation of its Elimination of Weapons Grade Production (EWGPP) Program and the challenges faced in shutting down the last three plutonium production reactors in the Russian Federation. DOE takes issues, however, with certain conclusions in the report; its concerns on these conclusions are also detailed below.

Now on pp. 30-32.

RESPONSES TO RECOMMENDATIONS (pages 35/36).

Recommendation 1. Continue to pursue the option of extending summer outage periods at the reactors as a way to realize the immediate nonproliferation benefits of reduced plutonium production in Russia.

Now on p. 17.

DOE Response. DOE was disappointed that Russia rejected a proposal to study ways to reduce the amount of plutonium produced by the reactors in the interim before they are shut down. As discussed elsewhere in the draft report (page 19), DOE had obtained funds to finance a study of three options for reducing near-term plutonium production. We believe that the primary reason that Russian officials rejected the proposal was that verifying production reduction would require at least limited access by DOE representatives to the nuclear facilities. DOE will seek clarification from Russian representatives regarding the access issue and investigate ways to mitigate Russian concerns with the hope of reaching agreement for extending summer outages. In any case, DOE will continue to pursue the proposal for early Russian shutdown of one of the Seversk reactors once an agreed stage of refurbishment of the fossil plant is completed and operating.

Recommendation 2. Reach agreement with Russia on the steps that must be taken to permanently shutdown the reactors and the specific requirements must be met to complete the replacement fossil fuel plants.

DOE Response. DOE has reached agreement with OKBM (the Russian reactor design agent), to conduct a technical and economic study of shutdown requirements for the three reactors. The study will tie completion of these requirements to milestones in the fossil projects. The contract for OKBM is currently being reviewed through the Russian interagency process. We expect to initiate the study by early summer and to have it completed by early fall 2004. This study will include engineering assessments of radiation systems, instrumentation and control equipment, metal structures, and concrete and graphite components. It will also verify closure techniques for specific systems. Lastly, it will contain a schedule of milestones for the shutdown process that can be tied to construction and

Now on p. 20.

refurbishment of the replacement fossil fuel plants and cost estimates for shutdown options. GAO acknowledges DOE's progress on the reactor shutdown issue later in the draft report (page 23). DOE also plans to develop a workforce transition plan directly with FAAE.

Recommendation 3. Identify any additional costs that may surface as a result of refining the scope of work associated with shutting down the reactors and completing the replacement fossil fuel plants and revise cost and schedule estimates for the program accordingly.

Now on p. 11.

DOE Response. As discussed in the draft report (page 13), DOE is using DOE Order 413.3 to conduct the program. This process requires projects to go through a series of five critical decision points. As part of this process, program management is developing final cost estimates for construction of the Zheleznogorsk plant and refurbishment of the Seversk plant. As these estimates are refined, senior Department management will be advised and program documentation modified appropriately.

Recommendation 4. Amend the March 2003 reactor shutdown agreement as soon as practicable to accurately reflect DOE's more realistic shutdown dates for Russia's three plutonium production reactors.

Now on p. 20.

DOE Response. DOE will seek to modify the reactor shutdown implementing arrangement to reflect revised completion dates once project designs are completed. This effort will be conducted in conjunction with Department of State. GAO acknowledges that DOE and State Department officials plan such action later in the draft report (page 23). It should be noted that at the conclusion of negotiations on the Implementing Agreement both sides were explicitly aware that the dates were "placeholders" and would be updated once sufficient information was available.

Recommendation 5. Create a specific plan and take steps to formally coordinate DOE's program to assist Russia's closure of the three plutonium production reactors with the Department's effort to find jobs for displaced Russian nuclear workers through the Russian Transition Initiatives.

DOE Response. The DOE offices responsible for the EWGPP Program and the Russian Transition Initiatives (RTI) established a Coordinated Working Group in November 2003 and are finalizing a joint plan to coordinate efforts to identify projects that will assist with workforce transition in the cities of Seversk and Zheleznogorsk, while also helping to transition the economies of those cities away from their reliance on WMD related activities. Specific efforts are discussed in the response to Recommendation 6.

Recommendation 6. Take the lead in developing a comprehensive plan that focuses on integrating U.S. efforts to employ Russian nuclear workers in the cities of Seversk and Zheleznogorsk.

3

Now on p. 22.

DOE Response. DOE recognizes that Russian officials believe that finding work for displaced nuclear workers is their highest priority (page 25). To this end, EWGPP and NNSA's Russian Transition Initiatives (RTI) are finalizing a joint coordination plan to ensure that as EWGPP program milestones are met, the worker transition challenge is addressed in a systematic and comprehensive way. The first priority of this plan will be to establish a U.S>-Russian joint committee that will include representation from the closed cities. This committee would focus on data collection with respect to the number of displaced workers, the timing for their displacement, their skills, their weapons knowledge, and other key demographic information. This plan will be the blueprint to guide the establishment of a significant RI presence in Seversk, and a ramp-up of RTI activity in Zheleznogorsk. This plan will outline how DOE will build and apply its unique technical expertise and experience in downsizing and in pursuing infrastructure transformation in the close cities to ensure a smooth transition in the two cities

Now on p. 23.

DOE is also sponsoring an international participation initiative that will provide Russian organizations the opportunity to develop and present projects to the international community for sponsorship. As stated later in the draft report (page 26), DOE has arranged for the Government of Switzerland to host a conference of interested participants in October 2004. This effort is being coordinated with the Russian Transition Initiatives program . We expect that Russian organizations will present about 25 project proposals to 10 to 15 countries at the Swiss conference. This type of initiative was previously used successfully by the Department in obtaining support for closure of the Kazakhstan BN-350 Breeder Reactor.

In addition to these Departmental activities, one of EWGPP's contractors has enlisted the support of an international management consultant to evaluate commercial projects in the Zheleznogorsk region to provide jobs for displaced workers.

Recommendation 7. Consider seeking financial support from Russia to construct the replacement fossil fuel plants.

Now on p. 27.

DOE Response. As stated in the draft report (page 31), DOE is concerned that relying on Russian financial support for the program will delay accomplishment of the critical nonproliferation goal of shutting down the three production reactors at the earliest opportunity. However, program management will address the issue with Russian officials to determine if greater contributions can be obtained. It should be noted that the Federal Agency for Atomic Energy (the successor to MinAtom) is already making significant contributions. For example, the Agency acquired the Zheleznogorsk site and is performing the nuclear safety upgrades.

Recommendation 8. Monitor funding requirements to ensure that funds are obligated in a timely manner.

4

DOE Response. Program management is acutely aware of Congressional concern about obligation and expenditure rates. The EWGPP Program currently has a substantial amount of unobligated funds because (1) $74 million was transferred with the Program when it was transferred from DOD and (2) the projects have not reached the construction phase. Initiation of the construction phase of the Seversk project by years end will reduce unobligated balances in the short term in FY05 and uncosted balances thereafter.

Recommendation 9. Determine whether future funding requirements need to be reduced in light of the slow rate of spending to date on the program.

Now on pp. 6, 26, and 27.

DOE response. As discussed in the draft report (pages 9, 27 & 30), the cost estimate for the two projects has risen substantially from the original estimate of $466 million. This is primarily due to Russian inflation since the estimate was developed in 2001. More importantly, to meet the aggressive shutdown schedule, particularly for Seversk, DOE does not believe that there will be an opportunity to reduce future funding requirements. However, DOE will equally aggressively pursue cost savings opportunities, which do not adversely affect the schedule.

OTHER COMMENTS AND CLARIFICATIONS

Now on pp. 5, 16, 17, and 28.

Draft report statement 1. Russia's recent rejection of its proposal to reduce the amount of plutonium being produced by the reactors raises serious questions about its commitment to the nonproliferation goal of the program (draft report pages 7, 18, 20, & 32).

DOE comment. DOE does not draw the same conclusion GAO does from these actions. As discussed in the response to recommendation 1, we believe that the primary reason for the Russian action was concern over DOE access to nuclear facilities rather than a commitment to the nonproliferation goal of the program. This opinion is supported by the Russian decision to reject the DOE offer to fund nuclear safety upgrades that would have also required access to restricted facilities.

In addition, as stated in the draft report, the Russian letter rejecting the plutonium production initiative expressed concern about the diversion of resources from the primary goal of building the fossil fuel replacement plants. We believe that this reflects Russian impatience with the pace of the program as it has moved from a core conversion project to a fossil fuel project and from DOD to DOE. One Regional Governor may have stated it best when he told one of the U.S. contractors that "I have provided you with a site, when are you going to start construction?" In summary, we do not see evidence of a lack of commitment to nonproliferation goals as much as concerns about socio-economic issues.

Now on pp. 7 and 27.

Draft report statement 2. DOE plans to bear full financial responsibility for building the replacement fossil fuel plants, which will be designed and built by Russia (draft report pages 9 & 31).

5

DOE comment. As cited in the draft report, the cost estimate for the program has increased substantially from the original estimate of $466 million. As a result, DOE is in the process of soliciting financial support from several nations for the Zheleznogorsk fossil fuel plant. To this end, a request for legislative authority to accept direct contributions was included in the Department's FY 2005 budget submission.

Draft report statement 3. DOE's Assistant Deputy Administrator, Office of International Nuclear Safety and Cooperation, told us that he was very pessimistic that Russia would perform the (nuclear) safety upgrades.

DOE comment. The official quoted would like to clarify. He meant that he does not believe that Russian upgrades will be as proactive and comprehensive as the PNNL proposal.

Draft report statement 3. NNSA's Assistant Deputy Administrator, Office of International Nuclear Safety and Cooperation, told us that he was very pessimistic that Russia would perform the (nuclear) safety upgrades.

NNSA comment. The official quoted would like to clarify. He meant that he does not believe that Russian upgrades will be as proactive and comprehensive as the PNNL proposal.

Comments from the Department of State

United States Department of State

Assistant Secretary and Chief Financial Officer

Washington, D.C. 20520

MAY 17 2004

Ms. Jacqueline Williams-Bridgers
Managing Director
International Affairs and Trade
General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548-0001

Dear Ms. Williams-Bridgers:

We appreciate the opportunity to review your draft report, "NUCLEAR NONPROLIFERATION: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges and Final Shutdown is Uncertain," GAO Job Code 360357.

The enclosed Department of State comments are provided for incorporation with this letter as an appendix to the final report.

If you have any questions concerning this response, please contact Michael Stafford, U.S. Negotiator, Bureau of Nonproliferation, at (202) 647-0258.

Sincerely,

Christopher B. Burnham

cc: GAO – Glen Levis
NP – Andrew Semmel
State/OIG – Mark Duda
State/H – Paul Kelly

Department of State Comments on GAO Draft Report
NUCLEAR NONPROLIFERATION: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown is Uncertain
(GAO-04-662, GAO Job Code 360357)

The Department of State appreciates the opportunity to review and comment on the draft report "Nuclear Nonproliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown is Uncertain." State believes that certain key conclusions in the report are either exaggerated or unwarranted, and further believes that the report does not support a judgment that final shutdown of the reactors is at risk. State does support all but one of the report's recommendations, however, and notes that it is already working with the Department of Energy and the Russian Federation to implement the steps that GAO recommends. Regarding the one recommendation State does not support, that the U.S. seek financial support from Russia to construct the replacement fossil fuel plants, we continue to believe that, if pursued, this would delay the realization of the program's overarching goal -- shutdown of the reactors. Instead, we are seeking financial support from other countries.

State objects most strenuously to GAO's conclusion that, because the Russians: (1) declined to pursue extended outages of the three reactors during the summer months prior to their shutdown (which would have reduced the amount of plutonium produced before shutdown), and (2) declined U.S. assistance for safety upgrades at the reactors prior to their shutdown, this indicates a lack of Russian commitment to the nonproliferation and safety-related goals of the program, thereby making the program "an increasingly risky undertaking."

- In drawing this conclusion, GAO emphasizes only selected parts of each Russian decision, providing an incomplete and misleading picture. While declining extended summer outages, the Russians at the same time agreed to pursue early shutdown of two of the three reactors, which would likewise serve the nonproliferation goal of reducing the amount of plutonium produced. Similarly, while they declined DOE assistance for safety upgrades, the Russians said they would finance safety upgrades themselves.

- Furthermore, GAO's conclusion that the Russian decisions reflected a lack of commitment to nonproliferation and safety is based on speculation by unidentified DOE technicians, whose views are not shared by either the State Department or DOE policy-level officials who dealt directly with the Russians on these policy issues. The preponderance of evidence, in our view, indicates strongly that the Russian decisions were motivated by their concerns about opening operating plutonium production reactors to U.S. officials to monitor implementation of summer outages or safety upgrades. The Russians consider such reactors to be highly sensitive national security facilities. Thus, we believe these decisions reflect Russian security considerations rather than their attitude toward nonproliferation or safety. In fact, the Russians continue to support those nonproliferation and safety-related elements that would not require monitoring of operating reactors, i.e., early shutdown and Russian-funded safety upgrades.

- Finally, and most importantly, the key to the program's success is the Russian commitment to the agreed outcome -- shutdown of the reactors -- not whether they may or may not share our reasons for that commitment. On this score, there are important reasons to remain confident in the Russian commitment. First, Russia does not need the plutonium produced by the reactors; in fact, we have been monitoring all such plutonium produced since 1995 to ensure that it remains in storage and unused. Second, the Russians themselves bear the greatest risk that these extremely unsafe reactors will suffer a catastrophic accident, a danger they take seriously, as we do. Third, absent this program, Russia would be hard-pressed to find the resources to provide alternative means of heat and electricity to the surrounding communities when the reactors would eventually be forced to shut down due to graphite stack deterioration. Therefore, implementation of the program is strongly in Russia's interests. Furthermore, the 1997 agreement that established the program, the Plutonium Production Reactor Agreement (PPRA), was signed at the highest levels of the two governments and linked to the Cooperative Threat Reduction (CTR) program. The consequences of any Russian decision to renege on the commitments therein, which would threaten the entire range of CTR assistance (approximately $1 billion per year) and more, serve as a powerful disincentive for such a prospect. Russian actions to date to implement this program reinforce

our belief that they remain strongly committed to achieving the agreed outcome.

State also objects to GAO's conclusion that final shutdown of the reactors is uncertain because the PPRA and its implementing agreement are insufficiently clear regarding the steps to be taken to permanently and irreversibly shut them down. The agreements are very explicit in obligating the Russians to shut the reactors down as soon as the replacement heat and electrical capacity is available, and in specifying deadlines for completion of these actions. Specific steps to complete creation of the replacement capacities and to effect the shutdown are appropriately specified in contracts and other implementation plans, and DOE is working with the Russians now to formulate these documents. This effort is clearly governed by the obligations and deadlines included in the agreements. As for ensuring irreversibility, the PPRA is quite clear on the steps to be taken. It specifies that, immediately upon their shutdown, the reactors will be covered by the monitoring regime applied to the currently shutdown reactors. This regime includes placement of seals on critical areas throughout the reactors that would have to be broken before the reactors could be restarted, and annual monitoring of the reactors to ensure that the seals remain intact and that no other steps have been taken toward a reactor restart. This regime has been applied to the currently shutdown reactors since 1997 with great success in order to ensure that their shutdown is irreversible, and we are confident that it will work equally well with the final three reactors.

State acknowledges that the deadlines for reactor shutdown currently specified in the agreements are no longer consistent with current plans, but believes GAO has greatly overstated the implications of this fact. When the currently specified deadlines were agreed upon by the U.S. and Russia in 2000, they represented our best estimate of the earliest dates when replacement fossil plants could be completed. We purposely chose ambitious deadlines to ensure that later dates did not become an excuse for delaying the program. The Russians and we also agreed that, as implementation plans were fleshed out, we would amend the agreements to revise the deadlines if it became apparent that the specified dates could not be achieved. The Russians and we plan to do so once designs are completed, which will give us a firmer basis for projecting completion dates. To do so sooner would only make likely that we would have to repeat the process once the designs were complete. The current situation is

thus one that was foreseen by both sides, and both sides have agreed to the process of adjustment. There is absolutely no reason, therefore, to believe that this is anything but a routine adjustment made during program implementation.

State also believes GAO is mistaken when it claims that worker displacement has the potential to undermine the program. Russia signed the PPRA at the highest level knowing that workers would be displaced by shutdown of the reactors and acknowledging that it was ultimately a Russian responsibility to address this problem. The U.S. has offered assistance, both through existing U.S. programs and by helping the Russians to seek aid from other countries, but the Russians have never tried to shift the ultimate responsibility from their own shoulders. It is clear to both sides that any attempt by Russia to use worker displacement as an excuse to renege on their PPRA commitments would constitute noncompliance with the agreement and trigger consequences, as described above, that would far exceed the cost of dealing with displaced workers.

Finally, State disagrees with the GAO recommendation that the U.S. consider seeking financial support from Russia to construct the fossil fuel plants. As GAO was told, we considered at the program's inception various ways in which Russia could provide support, and we concluded that any reliance on Russian funding for program elements that were critical to the construction schedule was bound to produce delays. This was because our long history of cooperation with Russia on related projects had shown that Russian funds were invariably provided either late or in amounts lower than promised, or both. In this case, that would mean that shutdown of the reactors -- the overarching purpose of this effort -- would be delayed. We concluded that avoiding such delays was more important than seeking what would surely be limited Russian cost-sharing. Instead, we agreed with the Russians that Russia would assume responsibility for actions that would not affect the construction schedule, including provision of infrastructure, decommissioning and dismantlement of the reactors after they were shut down, and operation and maintenance of the fossil plants once they were completed. State continues to believe that this course best serves our interests.

Instead of seeking direct Russian cost-sharing, DOE and State have begun efforts, as directed by Congress, to seek cost-sharing by other

nations, particularly those participating in the Global Partnership on Nonproliferation. The highest priority for such participation is funding to accelerate completion of the fossil plant, and thus shutdown of the reactor, at Zheleznogorsk. It is clear, however, that this funding would only accelerate the schedule if it could be provided without the delays that would occur if participating nations had to negotiate their own bilateral agreements with Russia. To avoid this, DOE would need to be able to accept the contributed funds directly and channel them to the project through the existing DOE-Minatom implementing agreement. DOE is currently not able legally to accept funding from sources outside the U.S. government for this program in this manner. Thus, legislative relief is needed. Without it, the funds would have to go through an entity such as the European Bank for Reconstruction and Development, which would use part of the money for overhead costs, a charge likely to discourage other countries from contributing. With legislative relief, DOE would be able to apply the full amount to the program.

DOE has proposed to Congress legislation that would give it the necessary authority, applicable only for this program and this purpose. State strongly supports the DOE proposal and believes that it is critical to realizing the paramount goal of this program: the earliest possible shutdown of the Russian reactors.

State supports GAO's other recommendations, and the Administration is taking or planning the following actions:

- As part of the implementation process, DOE and Minatom are currently developing a plan that fleshes out the specific steps that will be taken to put the fossil plants into operation and, simultaneously, effect shutdown of the reactors, in accordance with the obligations and deadlines specified in the PPRA and its implementing agreement.

- State plans to negotiate an amendment to the PPRA, per our agreement with the Russians, to reflect the new projected completion dates for the fossil plants, once the plant designs are completed. We anticipate that this will occur within the next year.

- State and DOE plan to develop a coordinated effort among the relevant programs, including the Russian Transition Initiatives program and the

International Science and Technology Center program, to assist Russia in addressing the worker displacement problem. In addition, State and DOE will continue helping Russia in its efforts to seek other international aid for this purpose.

GAO Contact and Staff Acknowledgments

GAO Contact

Jim Shafer, 202-512-3841.

Acknowledgments

In addition to the individual listed above, R. Stockton Butler, Nancy Crothers, Glen Levis, Steve Rossman, and Keith Rhodes, GAO's Chief Technologist, made key contributions to this report.

GAO's Mission

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