United States Government Accountability Office

GAO

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

July 2007

NUCLEAR SAFETY

Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties

GAO-07-923

July 2007

NUCLEAR SAFETY

Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties

GAO Accountability · Integrity · Reliability

Highlights

Highlights of GAO-07-923, a report to the Ranking Member, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, House of Representatives

Why GAO Did This Study

In 1986, an explosion at the Chernobyl nuclear power plant in Ukraine destroyed the reactor building and released massive amounts of radioactive contamination. A temporary shelter was built over the damaged reactor to prevent further contamination. The United States is a major donor to an international project to build a new shelter to replace the existing one, which is badly deteriorating. GAO was asked to (1) assess the progress toward completing the new shelter, (2) review the cost estimates to complete the project, and (3) assess the U.S. role in overseeing and funding the project. To carry out its work, GAO analyzed program documents, interviewed U.S. and international program officials, and visited the Chernobyl nuclear power plant.

What GAO Recommends

GAO recommends, among other things, that the Secretary of State consider, in consultation with other donor governments and the EBRD, establishing benchmarks for the project that need to be met before making additional pledges of funds in the future. State generally agreed with our recommendations. However, State cautioned that the use of benchmarks could lead to further project delays or increase costs. We strongly believe that benchmarks could encourage timely project completion at agreed upon costs.

www.gao.gov/cgi-bin/getrpt?GAO-07-923.

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.

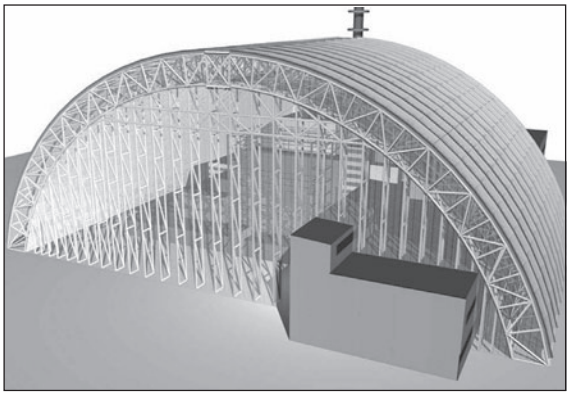
What GAO Found

Although two of three construction components—site preparation and stabilization of the existing shelter—are nearly finished, construction of the new shelter has fallen about 7 years behind schedule. Over the past couple of years, the main reason for schedule slippage has been the failure to award a construction contract. The lack of a contract is partly the result of a lengthy disagreement between Ukraine and the European Bank for Reconstruction and Development (EBRD). In late 2006, the Chernobyl nuclear power plant director told GAO that the donors should not make any additional contributions to the project until contracting issues were resolved. These problems contributed to donors' concerns about when and at what cost the project will be completed. In addition, technical uncertainties associated with the construction of the new shelter have also contributed to schedule slippages and threaten to further delay the project.

The estimated cost to complete the Chernobyl Shelter Project is currently $1.2 billion. However, a higher cost estimate is likely due to, among other things, escalating prices for labor and materials. Also, many other factors, such as expanding the project's scope to include the removal of the radioactive reactor fuel, could raise costs further.

The Department of State, which has the lead role for the U.S. government, relies on the EBRD to directly manage the project, including the disbursement of funds. The United States has pledged $203 million for the project but still has to provide $49 million to meet its current commitment. In addition, the United States will likely be requested to provide funds beyond the $203 million pledged because some donor governments may not have the resources or may no longer be willing to provide additional funds. To date, the United States has not placed conditions or benchmarks tied to tangible progress toward project completion on its contributions to the Chernobyl Shelter Fund.

Conceptual Design of the New Shelter



Source: Chernobyl Shelter Project Management Unit.

Contents

Tables

Figures

Abbreviations

ChNPP	Chernobyl Nuclear Power Plant
CSF	Chernobyl Shelter Fund
DOE	U.S. Department of Energy
EBRD	European Bank for Reconstruction and Development
IAEA	International Atomic Energy Agency
G-7	Group of Seven major industrialized countries
MOU	memorandum of understanding
NRC	U.S. Nuclear Regulatory Commission
PMU	project management unit
RBMK	reactor bolshoy moshchnosty kanalny
SIP	Shelter Implementation Plan
State	U.S. Department of State
USAID	U.S. Agency for International Development

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

July 19, 2007

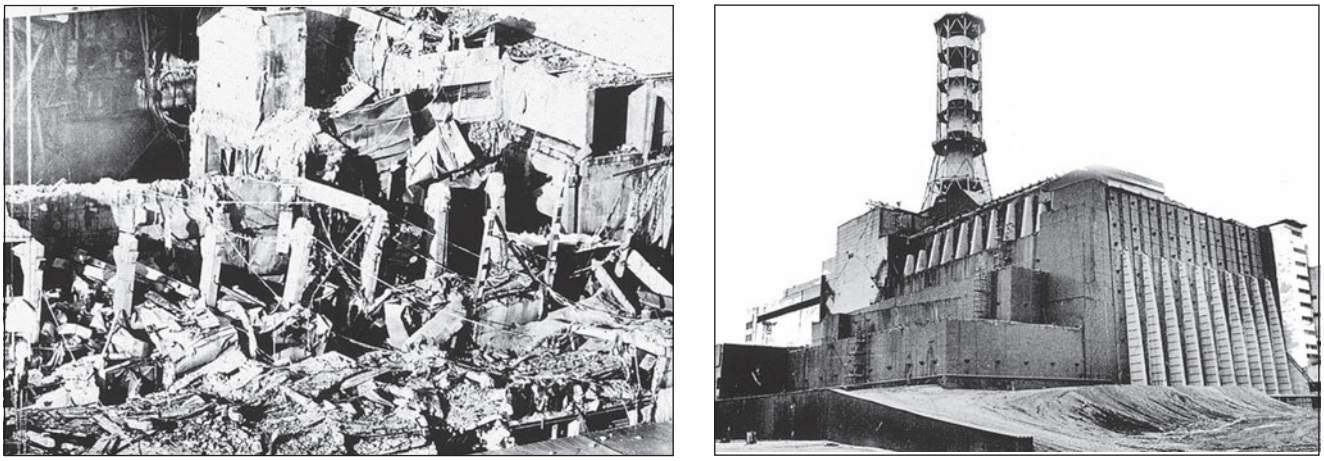
The Honorable Christopher Shays
Ranking Member
Subcommittee on National Security and Foreign Affairs
Committee on Oversight and Government Reform
House of Representatives

Dear Mr. Shays:

On April 26, 1986, the worst accident in the history of civilian nuclear power occurred at the Chernobyl nuclear power plant in Ukraine, where an explosion destroyed the core of reactor unit four containing approximately 200 tons of nuclear fuel.[1] The explosion also destroyed much of the reactor building, severed the reactor's cooling pipes and spewed hot fragments of reactor fuel from the core, igniting at least 30 fires in nearby buildings. The explosion and heat from the reactor core propelled radioactive material as much as six miles high, where it was then dispersed mainly over 60,000 square miles of Ukraine, Belarus, and Russia. Smaller amounts of radioactive material spread over eastern and western Europe and Scandinavia and were even detected in the United States. About 6 months after the accident, the construction of a 21-story-high metal and concrete shelter was completed to enclose the damaged reactor and confine the remaining radioactive material. This shelter—which was never intended to serve as a permanent solution for confining the long-lived and highly radioactive material—is badly deteriorating, and rain entering through holes and cracks is corroding and further weakening the structure. International nuclear safety experts, including officials from the International Atomic Energy Agency (IAEA), are concerned that the weakened shelter could collapse and release a radioactive dust cloud that could, among other things, create a health and safety hazard, complicate continuing accident recovery efforts, and have further adverse environmental impacts on the region. Figure 1 shows the impact of the explosion on the reactor building and the hastily built shelter that needs to be replaced.

[1]The Chernobyl Nuclear Power Plant had four operating reactors, designated as units one through four. Each reactor has a core designed to contain uranium fuel and control elements that are held within a sealed metal container. Additional information on the root causes and impact of the Chernobyl accident can be found in appendix I.

Figure 1: The Damaged Reactor Building and the Existing Shelter Built over It



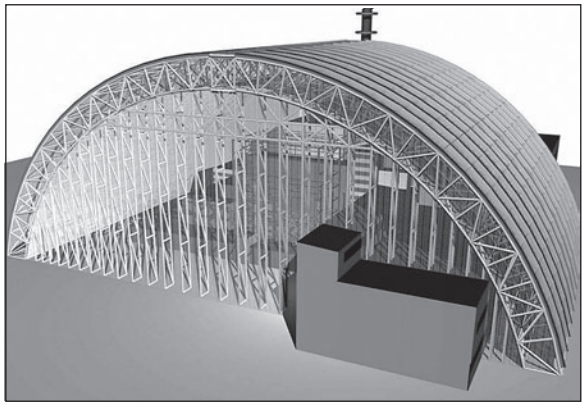
Source: Chernobyl Nuclear Power Plant.

The United States and other countries sponsored the development of a Shelter Implementation Plan (SIP), finalized in 1997, that outlined the steps to create safe conditions for the damaged reactor and the existing shelter. The SIP is the basis for an ongoing project to replace the existing shelter with a new one. The new shelter is technically known as the New Safe Confinement. For the purposes of this report, we refer to project activities performed under the SIP as the Chernobyl Shelter Project and refer to the New Safe Confinement as the new shelter.

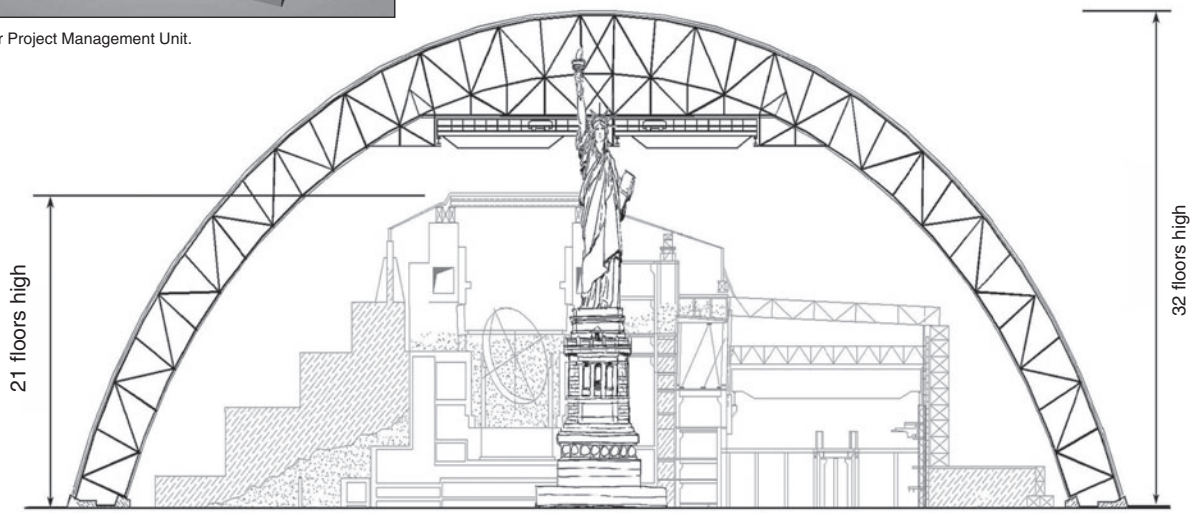
The new shelter is designed to be an arch-shaped structure enclosed by flat walls at each end, standing roughly 32 stories high and wider than two football fields at its base. To minimize the workers' exposure to radiation, the new shelter will be built at a distance from the existing shelter and then slid over it on concrete tracks. After it is in place, the new shelter is designed to reduce the exposure of the existing shelter to weather and minimize the release of radioactive dust resulting from a possible collapse of the existing shelter. This structure, which has an expected service life of at least 100 years, is also intended to support the deconstruction of the unstable upper portions of the existing shelter and the eventual removal of the remaining highly radioactive material that contains fuel from the damaged reactor core. As currently envisioned, the removal of this material will not be undertaken until a long-term storage repository is available, likely decades after the end of the shelter project. Ukraine will be responsible for removing this material and storing it, as this activity is outside the scope of the Chernobyl Shelter Project.

Figure 2 shows the conceptual design of the new shelter.

Figure 2: Design of the Proposed New Chernobyl Shelter



Source: Chernobyl Shelter Project Management Unit.



Source: Battelle Memorial Institute.

Framework design of the proposed new Chernobyl shelter and its relative height to the Statue of Liberty and the enclosed existing shelter.

In addition to replacing the shelter, the project has two other main construction components—preparing the site for construction and stabilizing the existing shelter to prevent its collapse. The project is financed by 29 countries and the European Commission, primarily through

donations to the Chernobyl Shelter Fund (CSF).[2] As of September 2006, payments to CSF, earned interest, and in-kind contributions had reached about $930 million.[3] At that time, almost $380 million from CSF had been spent for administrative costs and project contracts. Thus far, the United States has contributed about $154 million ($169 million adjusted for inflation) of the total $203 million it has pledged since 1997.[4] As the largest single-country donor, the United States has provided roughly 19 percent of total contributions to CSF, whereas the European Commission has contributed the largest portion, about 26 percent of all contributions.

U.S. funding has come from appropriations under the FREEDOM Support Act, which broadly supports economic and political reforms in Ukraine and other newly independent countries following the 1991 dissolution of the Soviet Union.[5] The United States and other countries gave the responsibility to administer the Chernobyl Shelter Fund to the European Bank for Reconstruction and Development (EBRD), a multilateral bank that invests in countries from central Europe and the former Soviet Union to help build market economies and democracies.[6] EBRD subsequently established a framework for the project, including the CSF rules that defined the roles for the bank and donor governments. In addition, a

[2]The European Commission is the European Union's executive body. The union's member countries are Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Some of these countries also donate independently to the Chernobyl Shelter Fund.

[3]The total does not include pledges that have not been paid into the fund. The European Bank for Reconstruction and Development (EBRD), which administers the fund, reports the total payments into CSF, expenditures, and other amounts in euros. The amounts reported here are derived from its most recent *Project Progress Report* of October 10, 2006, which reported these amounts as of September 30, 2006. We used the third-quarter 2006 exchange rate to convert the fund total and expenditures to U.S. dollars from euros.

[4]We adjusted the U.S. contributions for inflation using a gross domestic product price index. The proportions of U.S. and European Commission contributions are based on the contributions agreements from each country in euros, as reported by EBRD in its October 10, 2006, *Project Progress Report*.

[5]The act is more specifically named the Freedom for Russia and Emerging Eurasian Democracies and Open Markets (FREEDOM) Support Act of 1992, Pub. L. No. 102-511, 106 Stat. 3320.

[6]In addition to the Chernobyl Shelter Fund, EBRD administers the Nuclear Safety Account, a multilateral fund designed to address safety improvements in Soviet-designed nuclear power reactors. This account also supports other projects such as the construction of two facilities at Chernobyl that are needed to decommission the three other reactors at the site.

Framework Agreement between EBRD and Ukraine was ratified by the Ukrainian government, which created a legal basis for the project in Ukraine.

In addition to EBRD, at least 10 organizations play a role in the Chernobyl Shelter Project, including a joint committee of high level officials from EBRD and the government of Ukraine, and Ukrainian ministries and regulators.[7] An assembly of contributors—composed of representatives from the donor governments that pledged about $3 million or more—acts similar to a board of directors and approves the overall policy direction for the project.[8] EBRD provides its expertise to manage the fund and, among other things, provides grants to the state-owned Chernobyl Nuclear Power Plant (ChNPP), the Ukrainian organization that is ultimately responsible for the project. ChNPP established a management team—known as the project management unit (PMU)—with a staff of about 160 employees. The PMU, which is responsible for the day-to-day implementation of the project, is staffed by ChNPP employees and a consortium of consultants from three western companies: (1) Bechtel International Systems Incorporated, which provides the PMU's managing director and has lead responsibility for project management; (2) Battelle Memorial Institute, whose main tasks involve environmental, health, and safety issues; and (3) Electricité de France, a French company that provides technical expertise.[9]

As a major donor country, the United States plays a prominent role in the project's assembly of contributors. Although the Department of Energy (DOE) and the U.S. Nuclear Regulatory Commission (NRC) participated in

[7]Organizations and other entities include the Assembly of Contributors (or donor governments, including the European Commission); the Project Management Unit, including the western consultant consortium; the Chernobyl Nuclear Power Plant; EBRD's International Advisory Group; Ukraine's State Nuclear Regulatory Committee; the Licensing Consultant that assists the Nuclear Regulatory Committee; Ukraine's Ministry of Emergency Situations that has responsibility for Chernobyl issues; and the Ukraine-EBRD Joint Committee.

[8]The following countries and organizations have formally pledged at least the minimum amount of funding to become members of the assembly of contributors: Austria, Belgium, Canada, Denmark, the European Commission, Finland, France, Germany, Greece, Ireland, Italy, Japan, Kuwait, Luxembourg, the Netherlands, Norway, Poland, the Russian Federation, Spain, Sweden, Switzerland, Ukraine, the United Kingdom, and the United States. Additional donors to the shelter fund include Iceland, Israel, Korea, Portugal, the Slovak Republic, and Slovenia.

[9]Electricité de France has nuclear expertise from operating 58 nuclear power plants.

various safety and regulatory tasks for the Chernobyl Shelter Project early on, they no longer have any direct responsibility for the project. The Department of State (State) serves as the primary U.S. government agency for Chernobyl shelter-related matters. In addition, the U.S. Agency for International Development (USAID) supports State and, among other things, administers payments to the shelter fund.

Because of the significant U.S. investment in this project and an interest in seeing its timely completion, you requested that we undertake a review of U.S. and international efforts to construct a new shelter. In response to your request, this report (1) assesses progress toward completing the new shelter and factors that impact completion, (2) reviews the cost estimates to complete the project, and (3) assesses the U.S. role in overseeing and funding the project.

To examine the Chernobyl Shelter Project's progress, we analyzed documentation and interviewed EBRD officials in London and Ukraine, Ukrainian officials in Kyiv and at the Chernobyl site, and officials with the PMU in the United States and at Chernobyl. We also reviewed project progress reports, management audits, project schedules, and risk assessment documents. To review the project's estimated costs, we obtained data from and discussed these cost issues with officials from the United States and other donor governments, EBRD, and the PMU. We also reviewed project cost estimates and EBRD summaries of project contributions by the donor governments. To determine the United States' role in overseeing and funding the project, we interviewed and obtained documentation from State and USAID. We also interviewed DOE and NRC officials to obtain information about their agencies' roles in providing assistance to Chernobyl. We performed our work from May 2006 through June 2007 in accordance with generally accepted government auditing standards. Further details of our scope and methodology are presented in appendix II.

Results in Brief

Although two of three construction components—site preparation and stabilization of the existing Chernobyl shelter—are nearly finished, completion of the project's final major and most visible component—the new shelter—is about 7 years behind schedule. The schedule to complete the new shelter has slipped from 2004 to no sooner than 2011. Over the past couple of years, the main reason for schedule slippage has been the failure to award a contract to construct the new shelter, which has developed into a lengthy and contentious issue between Ukraine and EBRD and raised concerns among the donors about when and at what

cost the project will be completed. Specifically, Ukraine disagreed with the likely selection of a French contractor to construct the new shelter, but EBRD contended the selection process could not deviate from the bank's procurement rules. By the fall of 2006, the disagreement had so strained relations between Ukraine and EBRD that the Chernobyl plant director told us the donors should not make additional contributions until contracting issues are resolved. More recently, however, an EBRD official said that relations were improving. In addition, frequent changes in Ukrainian leadership responsible for the project, overall project management complexity, and technical uncertainties associated with the construction of the new shelter have also contributed to schedule slippages and threaten to further delay the project:

- The lack of stable leadership and continuity among key Ukrainian organizations and officials has and could continue to create delays. For example, in the last 6 years, there have been four plant directors who are responsible for all major Ukrainian decisions for the project. According to a senior PMU official, the frequent change of directors affects the schedule because the project is forced to adjust to each director's new approach.

- The many organizations that impact the project's performance—including the assembly of contributors, EBRD, as well as Ukrainian ministries and regulators—have made it difficult to reach unanimous and quick agreement on project decisions.

- Technical uncertainties associated with constructing a one-of-a-kind structure at a radioactively contaminated site could also result in delays. The new shelter's final design will require the approval of Ukraine's regulatory agencies. If the final design deviates significantly from the already approved conceptual design, the regulators may require additional time to review and clarify new design issues. Moreover, if unexpectedly large amounts of high-level radioactive waste are found on site, work could be stalled while details for removal and storage are resolved.

The estimated costs of completing the Chernobyl Shelter Project are currently $1.2 billion and will likely increase. In 1997, a preliminary estimate of $758 million was developed to allow fund-raising for the project to begin. This estimate excluded a variety of costs that were later added to make a more thorough estimate—such as reserve funds to provide for project uncertainties and risks as well as rising material and labor prices. When these costs were added in 2003, the total estimated cost increased to over $1 billion. The estimate rose again to $1.2 billion in 2006, which primarily reflected reconciling the estimated cost of constructing

the new shelter with actual contractor bids. EBRD officials told us that the final project cost continues to be difficult to estimate because the single most expensive project task—the construction of the new shelter, estimated to cost over $500 million—has not begun. However, a higher cost estimate than $1.2 billion is likely because of, among other factors, rising prices for labor and materials during the delay in awarding the new shelter contract, according to a PMU cost expert. PMU officials and representatives from several donor governments, including the United States, stated that many other factors, such as expanding the project's scope to include the removal of the radioactive fuel from the reactor, could lead to further cost increases. Many of these representatives are also concerned that shelter costs are likely to rise because internationally funded construction projects often experience significant cost overruns. For instance, Chernobyl's plant director said the project could repeat the pattern of schedule delays and rising costs found in other Chernobyl projects. One of those projects—the construction of a facility to store spent nuclear fuel—was suspended in 2003 because of design flaws. An additional $150 million to $200 million—on top of the $96 million already spent—may be needed to modify or completely rebuild the facility.

The U.S. State Department, which has the lead role for the U.S. government, does not directly manage or oversee the Chernobyl Shelter Project, but it does provides funding through EBRD. Similar to the other contributors, State relies on EBRD to provide oversight and management of the Chernobyl shelter fund. The project's management structure limits State's role, but the agency primarily seeks to exert influence on the project's direction and performance through the assembly of contributors. However, State's role in influencing the project's direction is constrained because all major decisions must be based on consensus of assembly members. Despite these limitations, State recently played a key role in trying to move the project forward. Specifically, State took the lead at an October 2006 assembly meeting to address issues between EBRD and Ukraine about the selection of a contractor to complete the new shelter. State's proposal—to have a Ukrainian-selected observer monitor continuing contract negotiations—was accepted by the contributors and Ukraine as an interim step toward awarding the final contract. Regarding State's role in providing project funding, State officials said the department intends to pay the remaining $49 million of the $203 million pledged by the United States to the Chernobyl Shelter Project, even though FREEDOM Support Act funds, which are State's exclusive source for funding the project, have been decreasing. The United States will likely be requested to provide funds beyond those already pledged because, under current project cost projections of $1.2 billion, additional funds

totaling about $190 million will be needed from the donors. According to State and United Kingdom officials, some donor governments may not have the resources—or may no longer be willing—to provide funds beyond those already pledged. To date, the United States has not placed conditions on the contributions made to the Chernobyl Shelter Fund—that is, specific benchmarks tied to tangible progress toward project completion. Moreover, since State may need to approach the Congress for additional funds, the Congress, in our view, will need more information than currently provided. State has not systematically provided the Congress with detailed information about the project's status, including cost estimates and schedule slippages. Rather, in its annual congressional budget justification for foreign assistance, it only provides a brief statement about its continuing financial support of the shelter project.

To help ensure that the United States has a clear and consistent strategy, as well as a sound basis for continuing to support the Chernobyl Shelter Project, we are recommending that, among other things, the Secretary of State consider, in consultation with other donor governments and the European Bank for Reconstruction and Development, establishing benchmarks for the project that need to be met before additional pledges of funds are made. In addition, to increase State's accountability and transparency for funding the project, the Secretary of State should provide a detailed annual report to the Congress about the status of the project, including project costs, project milestones, and estimated completion dates.

We provided the Department of State and the U.S. Agency for International Development with draft copies of this report for their review and comment. In their written comments, both State and USAID agreed with our main findings and State generally agreed with our recommendations to the Secretary of State. However, both State and USAID raised some concerns regarding the establishment of specific benchmarks for the project. Both agencies asserted that linking additional funds to specific performance benchmarks requires careful consideration because it could lead to further project delays or increase costs. We strongly believe that benchmarks could encourage timely project completion at agreed upon costs.

Background

The Chernobyl accident left Ukraine with a costly legacy of population displacement as well as a host of health care and economic problems. Approximately 116,000 area residents in 1986, and another 220,000 in subsequent years, were evacuated and in need of resettlement from the

most heavily contaminated areas in the region. Although international nuclear safety and health experts report that 30 workers died in 1986 from the explosion or severe radiation exposure, the magnitude of longer-term health consequences resulting from the accident is still being investigated. According to the United Nations' Chernobyl Forum, the regional health impacts of the Chernobyl accident remain a concern 20 years after the accident. Of particular concern is the large number of thyroid cancer cases among children who drank milk that was contaminated by radioactive fallout from the Chernobyl accident. In addition, in a 2006 United Nations sponsored report, international health experts predicted that radiation could cause up to 4,000 eventual cancer deaths among the higher exposed Chernobyl populations, such as the emergency workers who helped put out the fires and build the original shelter.

In addition to the human toll, the Chernobyl accident has resulted in significant economic costs to Ukraine. These costs, which are difficult to quantify, include the removal of agricultural land and timber forests from production as well as the closure of agricultural and industrial facilities to protect people from further radioactive contamination. One major concern to Ukraine has been the displacement of about 6,000 workers who were employed by the ChNPP. Finally, costly government expenditures to remediate contaminated areas, provide medical services and social benefits for the affected populations, and restore the region's social and economic well-being have placed a heavy burden on Ukraine's national budget. Ukraine still devotes 5 percent to 7 percent of total government expenditures to Chernobyl-related benefits and programs.

U.S. participation in the Chernobyl Shelter Project began as part of a larger U.S. and international effort to improve the safety of Soviet-designed civilian nuclear power reactors. This effort, which was established in the early 1990s, targeted the highest-risk Soviet-designed reactors for short-term safety upgrades until they could be permanently shut down.[10] As part of this effort, in 1995 Ukraine, the European Commission, and the "Group of Seven" major industrialized countries (G-7), including the United States, signed a memorandum of understanding (MOU) about the closure of the remaining operating reactors at the

[10]For more information about this assistance, see GAO, *Nuclear Safety: Concerns with the Continuing Operation of Soviet-Designed Nuclear Power Reactors*, GAO/RCED-00-97 (Washington, D.C.: Apr. 25, 2000).

ChNPP.[11] The MOU—which led to the closure of the last operating reactor at Chernobyl in late 2000—also stated that a cost-effective and environmentally sound approach to address the damaged shelter would be cooperatively developed.

U.S. assistance with Chernobyl-related problems has also evolved within broader policy objectives to forge a political and economic relationship with Ukraine. Since the Soviet Union's dissolution led to Ukraine's independence in 1991, the United States has sought to support its transition to a democratic society with a market-based economy that is more closely integrated with Europe and the United States. As part of this assistance, the United States has been a major contributor of funds to help Ukraine address social, economic, and health problems associated with the accident and its aftermath. For example, State reports its programs for Ukraine have funded the delivery of $582 million in humanitarian assistance since 1992, which were collected from private donations and the Department of Defense. Approximately one-half of this assistance was targeted to those affected by the Chernobyl accident. The United States has also invested nearly $12 million in health programs. These programs included screening and treatment for childhood physical and mental illnesses related to Chernobyl radiation, breast cancer awareness, and access to modern cancer treatment.

Construction of the New Shelter Is about 7 Years behind Schedule and Could Face Further Delays

Two of the Chernobyl Shelter Project's three major construction components—site preparation and existing shelter stabilization—were nearly finished at the end of 2006, about a decade after the project's plan was developed. However, the project's largest construction task—building the new shelter—is not expected to be completed until about 7 years after the original scheduled completion date of 2004. As a result of protracted delays in awarding the contract to design and build the new shelter, construction has not yet begun. Furthermore, problems surrounding the project have strained relations between EBRD and Ukrainian officials, raising concerns among the donors, including the United States, about the prospects for completing the project. Moreover, frequent leadership changes among Ukrainian ministries and officials, management difficulties associated with the many organizations participating in the project, and technical uncertainties related to constructing a one-of-a kind structure

[11]The G-7 consists of the governments of Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

have delayed and could continue to delay the completion of the new shelter.

Work to Prepare the Chernobyl Site and Stabilize the Existing Shelter Is Nearing Completion, but Construction on the New Shelter Has Not Yet Begun

Two major activities integral to the Chernobyl project are nearing completion—providing infrastructure improvements at the Chernobyl site and stabilizing the existing shelter to prevent its possible collapse. Both of these activities are essential precursors to replacing the existing deteriorating shelter with a new one. Specifically, site preparation was necessary to create facilities and infrastructure services to support the construction work on both the existing and new shelters. Some infrastructure tasks remain to be done, such as an Integrated Automated Monitoring System, which monitors structural movements, seismic vibrations, radiation, and nuclear measurements within the existing shelter. Also, a decision to refurbish or construct a sewage treatment plant is still under consideration. Nevertheless, many support facilities and infrastructure services were operational by early 2005. The completed site preparation work includes refurbishing power, water, and drainage infrastructure as well as providing road and rail connections to two operations areas that support existing shelter stabilization and new shelter construction. In addition, a building with change rooms, showers, and radiological monitoring facilities—known as a change facility—has been constructed for controlling the access of workers to the construction site. This building will allow up to 1,430 workers involved in the construction of the new shelter to change their work clothes daily as a precaution against a possible spread of radioactive contamination. This building also includes medical and ambulance facilities for responding to medical emergencies. Figure 3 shows the change facility that will support the health and safety needs of the Chernobyl construction workers responsible for building the new shelter.

Figure 3: Completed Change Facility at the Chernobyl Site

Source: Chernobyl Nuclear Power Plant.

The second major construction component—the measures to stabilize and thus minimize the likelihood of the existing shelter's collapse—was essentially completed at the end of 2006. According to a PMU official, the main remaining tasks are a monitoring period through about September 2007, which will lead to a determination about the possible need for some additional work, and the commissioning of the stabilization measures. Although emergency stabilization of the shelter's roof structures and an adjacent ventilation stack was completed in the late 1990s, the bulk of the stabilization activities started in December 2004 and was completed 2 years later. Analysis of the risks of radiation exposure to workers from the stabilization work and the probability and consequences of shelter accidents led to a project decision to pursue only 9 stabilization measures, instead of the original 29 measures recommended by a PMU contractor. These 9 measures focus on strengthening the existing shelter's walls and roof support beams in particular places. For example, the last of these measures was to transfer about half the weight of the heavy roof load from the western wall of the reactor building onto support towers. Figure 4

shows a portion of the metal support towers that are intended to stabilize the main roof beams.

Figure 4: Stabilization Work for the Western Wall

Source: Chernobyl Nuclear Power Plant.

Despite the progress achieved on the two construction activities, the schedule for completing the new shelter—the third and most visible construction component—has slipped by about 7 years. The 1997 SIP established a preliminary schedule for completing the new shelter construction in March 2004. However, by late 2006, the Chernobyl PMU had extended the completion date to January 2011.[12] The 1997 implementation plan had included unrealistic schedule assumptions. For example, according to an EBRD official responsible for the Chernobyl Shelter Fund (CSF), the SIP assumed the western contractors providing project management (Bechtel International Systems Incorporated, Electricité de France, and Battelle Memorial Institute) would be in place immediately. However, this did not occur until early 1999, after Ukrainian decrees were finally developed to support the project. Specifically, in February 1999, the Ukrainian Cabinet of Ministers issued a decree releasing contractors from civil liability for nuclear damage, a prerequisite before contractors would consider working at Chernobyl.[13] Moreover, according to EBRD, the emergency repair to the shelter in 1999 showed it would be impossible to do significant work at the Chernobyl site without major investment in site infrastructure. Major portions of the support facilities and infrastructure, such as roads and water services, did not become operational until early 2005.

In addition, according to EBRD, the SIP did not allocate sufficient time for the technical and regulatory reviews and subsequent Ukrainian government approvals. The review process added 2 years to the project's schedule. PMU officials stated that other reasons contributed to delays. They indicated the largest single delay was the start of the conceptual design about 3 years after its original schedule. These officials attributed the delay to the time needed after the breakup of the Soviet Union to create a sufficiently mature Ukrainian infrastructure—such as banking and legal systems—to support a contract for the conceptual design. As a result of the unrealistic assumptions and on-the-ground conditions, by July 2004, the project had only advanced to the point of having the new shelter's preliminary design, known as a conceptual design, approved by the

[12]According to the 1997 plan, the total project was scheduled to be completed after the deconstruction of the roof and unstable parts of the existing shelter, which was expect to be finished about a year and a half after completion of the new shelter.

[13]In Ukraine, various government agencies generally use decrees to establish and promulgate orders and regulations.

Ukrainian Cabinet of Ministers—about 3 months after the date that the SIP had forecast completing construction of the new shelter.

An EBRD official told us, however, that the SIP was never expected to provide a precise schedule because major project questions such as the design for the new shelter had yet to be addressed. Moreover, the official said that the SIP had established an artificial start date of January 1997. According to an EBRD report, the project had a largely defined scope and schedule by 2003. Nevertheless, we found that the new shelter's completion date has continued to slip even after the new shelter's design was significantly clarified and the schedule was revised to reflect project refinements. As of late 2006, the scheduled completion of the new shelter was more than 2 years later than estimated in 2003.

Over the past couple of years, the primary reason for further schedule slippages of the Chernobyl project has been the failure to award a contract for the final design and construction of a new shelter. Until this contract is awarded, the project cannot go forward. In 2003, the PMU estimated that the contract for final design and construction would be awarded in 2004. As of early July 2007, however, the contract has not been awarded. As a result, the final design and construction of the new shelter has not yet begun.

Several procurement-related problems have delayed the contracting process from the beginning. For example, the request for contract bids was released in March 2004, which was about 2 months later than forecasted at the time. In addition, the proposal submission deadlines for both the technical and commercial evaluations of bids were each extended over a month. Moreover, despite lengthy clarifications of contract requirements with potential bidders, the two bidding consortiums—one led by a U.S. firm CH2M Hill and another called Novarka headed by a French firm—submitted proposals that did not comply with the requirements. The noncompliant proposals tendered by the two consortiums had to be resubmitted for consideration by the proposal evaluation committee.

More recently, the likely awarding of the contract to the French-led consortium as the lower bidder has created controversy, as Ukraine has raised objections and CH2M Hill filed a bid protest with EBRD.[14] The

[14]In April 2007, a PMU official informed us that CH2M Hill was no longer participating in the competition for the shelter contract.

ChNPP director and an official from the Ministry of Emergency Situations told us they believe the Novarka bid proposal contains significant deviations from contract requirements, which runs contrary to the majority view expressed in the proposal evaluation committee's report.[15] Ukraine began disagreeing with EBRD over the selection process in March 2006 when Ukraine sought to reopen the proposal evaluation process or restart the contracting process. In response to a Ukrainian request to overturn EBRD's nonobjection to the evaluation committee's report, a bank official refused, responding that no new information had been provided for consideration.[16] When CH2M Hill filed a bid protest shortly thereafter, EBRD halted the contracting process and initiated a 6-month investigation to ensure that the contract processing had been conducted in accordance with EBRD procurement rules. Based on its examination, EBRD concluded in September 2006 that CH2M Hill's complaint could not be upheld and the contracting process could continue. Then, Ukraine again raised objections about the contracting process and its likely outcome. As of May 2007, a PMU official told us that PMU and Novarka officials were still negotiating open points about the Novarka proposal that must be settled before the contract is awarded.

EBRD must certify the contract as being in accordance with bank procurement rules and the ChNPP director must approve the contract before it can be executed. However, based on our discussions with both EBRD and the ChNPP director in October 2006, it was clear that relations between both sides were extremely strained. For example, the ChNPP director told us that the donors should not make additional contributions to the shelter fund until contracting issues are resolved. An EBRD official told us that the bank would consider withdrawing from administering the project if the assembly of contributors approved Ukrainian proposals that conflict with EBRD procurement rules. However, in May 2007 an EBRD official told us that relations with Ukrainian officials have been gradually improving.

[15]We were unable to examine the specifics of the Ukrainian complaint, the bid protest, or the contract proposals because the contracting process is confidential under EBRD rules until the contract is awarded.

[16]EBRD describes an affirmative outcome of a bank review of a project document as providing a "nonobjection," which it distinguishes from an approval of the document. For example, EBRD said that its nonobjection to a contract certifies that the procurement processes and proposals are in accordance with governing policies and rules but is not an approval of the contract. According to an EBRD official, approval of a contract is the responsibility of the recipient of the CSF grant, such as ChNPP.

Officials from several donor governments told us they were growing increasingly concerned about the delays in awarding the contract for the new shelter's final design and construction. European Commission officials asserted that the donors were losing patience with the project and that it was becoming more difficult to justify continued financial support. The officials noted that the European Commission had to convince its approximately 400 million taxpayers that their investment was worthwhile. Given the growing concerns over costly delays, State officials said that the overarching need is the timely completion of a fair and transparent contracting process, regardless of which qualified bidder is selected. In their view, it is important to keep the project moving forward to demonstrate that all parties involved are serious about completing the new shelter as expeditiously as possible.

Frequent Project Leadership Changes, Management Difficulties, and Technical Uncertainties Have Delayed and Could Further Delay the Completion of the New Shelter

In addition to the problems associated with awarding the new shelter contract, several factors have also contributed to schedule slippages and threaten to further delay the project even after the contract is awarded. These factors include (1) frequent changes in the Ukrainian leadership responsible for the project, (2) overall project management complexity, and (3) technical uncertainties associated with constructing the new shelter.

Lack of Stable Project Leadership

Frequent project leadership changes have created, and could continue to create, schedule delays. For example, ChNPP directors are politically appointed and responsible for major Ukrainian decisions for the Chernobyl Shelter Project, including approving the construction contract for the new shelter. In the last 6 years, there have been four ChNPP directors, the latest appointed in mid-2005. According to a senior PMU official, the frequent changing of ChNPP directors created delays because the project had to adjust to accommodate each director's new approach to implementing the project. Furthermore, the project was stalled for months in 2005 as a result of a major Ukrainian government reorganization following a presidential election that shifted authority over ChNPP from the Ministry of Fuel and Energy to the Ministry of Emergency Situations.

Two former high-ranking Ukrainian officials told us that the changes in leadership have had a negative impact on the Chernobyl Shelter Project. A former official from the Ministry of Fuel and Energy told us the change was disruptive to the shelter project's progress because the Ministry of Emergency Situations wanted to revisit past project decisions and no

personnel from the Ministry of Fuel and Energy were transferred to the newly responsible ministry to maintain continuity of expertise. Similarly, the former head of Ukraine's regulatory organization asserted that the recent change in government resulted in the loss of many capable regulatory officials who had institutional knowledge of the project. As a result, some past decisions were overturned and many new questions were being raised about regulatory matters that had been previously addressed.

The possibility of continuing leadership changes creates uncertainties for the project's schedule. According to a senior PMU official, the current project schedule does not account for the risks of delays arising from political leadership and policy changes—not because such risks do not exist but because they are difficult to assess. EBRD has indicated that sustaining high-level Ukrainian government attention and a stable institutional environment is particularly crucial in this project phase, where any delay is costly. EBRD established the Ukrainian and EBRD Joint Committee in 1998 to promote government attention and to ensure that Ukrainian policies and institutions support the project's progress. Over the years, the joint committee has addressed various project issues requiring Ukrainian government actions, including tax and customs exemptions and Ukrainian contributions to the project. However, the joint committee has had mixed experiences in maintaining good cooperation. According to an EBRD official, the joint committee has been effective at creating some periods of good cooperation with the Ukrainian government, including occasions when the Ukrainian president has intervened to resolve project issues. However, frequent changes in Ukrainian officials have made it hard to maintain the continuity of the joint committee and to schedule meetings. An EBRD official told us that political and institutional instability has had a crucial impact on the progress of the project. He said that since 1998 the bank has worked with nine Ukrainian ministers involved with Chernobyl, eight vice prime ministers, six prime ministers, and an even higher number of deputy ministers or officials in charge of the ChNPP.

Complex Project Management Structure

A second risk to the schedule is the complex nature of the Chernobyl Shelter Project's management structure, which has slowed decision

making.[17] There are many organizations that impact the project's performance—including the assembly of contributors, EBRD, the western contractors, the PMU, ChNPP, as well as Ukrainian ministries and regulators. Numerous officials from these organizations told us that the multiple organizations involved in the project creates a cumbersome structure that has made it difficult to reach timely and unanimous agreement on project decisions. From the PMU managing director's perspective, although the PMU structure provides EBRD and the donors with transparency for shelter fund spending, it involves more time-consuming accountability for even minor expenditures than he has experienced on other international construction projects. For awarding a contract, a series of steps, each of which can take a week or longer, must be completed. EBRD must provide nonobjections to the PMU on the contract request, on the contractor selection, and for signing the contract. In addition, contracts must be approved by the ChNPP director, which can also be time consuming. The PMU managing director also noted that decision making is also complicated because he must obtain concurrence from both EBRD officials and the Chernobyl plant director. This can prove difficult because the PMU serves both clients and must sometimes resolve contradictory directions from the two project participants.

A root cause of the management difficulty we identified is the unresolved issue of how much control the PMU should have in managing the project on behalf of the ChNPP. In 2002 and 2005, independent audits contracted by EBRD concluded that the ChNPP manager's efforts to exert greater control over the PMU led to inefficient decision making and project delays. Those efforts had negative effects because ChNPP management became overly involved in detailed project decisions or duplicated PMU reviews before approving decisions. ChNPP officials told us that a plant work group was established to review decisions made by the PMU. They view this duplication of effort as necessary because the decisions prepared by the PMU for the ChNPP director's approval do not always reflect the full interests of the plant.

[17]We have reported on other international construction projects with complex management structures. Specifically, a DOE-funded construction project to build fossil fuel plants to replace plutonium production reactors in Russia had 17 U.S. and Russian organizations participating in the project. DOE officials told us that the numerous organizations involved in managing the complex program made coordination difficult, which has led to delays. For more information, see GAO, *Nuclear Nonproliferation: DOE's Efforts to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, GAO-04-662 (Washington, D.C: June 4, 2004).

Ukrainian ministerial and ChNPP officials told us they want greater control over the PMU—and the shelter project in general—rather than having the PMU managed by a western consultant, as is specified under the ChNPP's current contract with the consortium of consultants from three western companies. A senior official at the Ministry of Emergency Situations told us that there were too many western consultants in senior management positions in the PMU. He asserted that Ukraine should be treated like an equal partner in the project because Ukraine is legally responsible for the project and thus ultimately responsible for the safety of the site once the shelter is completed.

In contrast, EBRD believes that the current management arrangement corresponds with shelter fund agreements and reflects the findings of the two management audits, which recommended against more intervention by ChNPP management into PMU operations. In EBRD's general model for administrating funds, western consultants ensure the PMU has the necessary management, procurement, financial, and other skills. EBRD has described Ukrainian proposals to assembly members as marginalizing the important role of western consultants. However, changes to the PMU structure have been made as the result of recommendations in previous audits. For example, the co-leadership in all PMU management positions—a western consultant and a Ukrainian manager for each position to provide training for Ukrainian staff—was discontinued to speed up decision making. Currently, about half of the PMU management positions are filled by Ukrainian managers developed under the earlier co-leadership structure.

In October 2006, the assembly of contributors requested an update of the last management audit as a basis for determining whether further management improvements are needed. The resulting May 2007 audit report did not support ChNPP managers' proposal to restrict western consultants' functions to mainly providing advice to ChNPP. Instead, the audit recommended that the project should continue to be managed by the PMU on behalf of ChNPP and that PMU functions and responsibilities should be gradually transferred to Ukrainians as qualified candidates are found.

Technical Uncertainties

The Chernobyl Shelter Project faces a number of technical uncertainties associated with constructing a one-of-a-kind structure at a highly radioactively contaminated site. These uncertainties could contribute to project delays. For example, the new shelter's final design will require approval from Ukraine's regulatory agencies, including those responsible for regulating nuclear materials and approving construction projects. To

avoid the delays that have occurred in past reviews, Ukrainian law limits the duration of the regulatory review process for the new shelter. However, licensing consultant officials who provide support services to Ukraine's nuclear regulator under an EBRD grant told us that the law requires only a review, and not approval, within that duration. If the approval documents are of poor quality, such as missing supporting information, or raise technical questions, then the review process could be prolonged while the documents are revised and resubmitted. Technical questions are particularly possible during the review because the contractor may propose alternatives to meet the technical requirements of the conceptual design. As a result, the shelter's final design could be different from the conceptual design that the regulator had already approved. Regulators may then require additional time to review and clarify new design issues, which could delay the authorization to begin construction on the new shelter.

Moreover, if unexpectedly large amounts of high-level radioactive waste are found on site, work could be stalled while removal and storage issues are resolved. According to the PMU's managing director, the main concern is the amount of radioactive waste that may be uncovered during the excavation for the new shelter's foundation. PMU officials report that ChNPP is currently expanding its capacity for on-site storage of high-level radioactive waste. Nevertheless, if the amount of high-level radioactive material discovered during the construction of the new shelter is higher than expected, the amount of waste may exceed the limited available space for storing this material. According to another PMU official, although the ChNPP is responsible for removing and storing the high-level radioactive waste, these tasks would have to be done in a timely manner in order to allow the new shelter contractor to stay on schedule.

Estimated Costs to Complete the Project Are $1.2 Billion and Will Likely Increase, and Final Costs Are Uncertain

As of 2006, the costs to complete the Chernobyl Shelter Project were estimated at over $1.2 billion and are likely to increase due to, among other things, ongoing project delays. In 1997, a preliminary estimate of $758 million was developed that excluded certain cost factors such as reserve funds to provide for project uncertainties and risks, as well as increased material and labor costs. Final project costs are currently difficult to estimate because the most expensive project task—the construction of the new shelter—has not started. Officials from several donor governments are concerned that the costs of the Chernobyl Shelter Project will exceed the current $1.2 billion estimate. These concerns are based in part on their experiences with other internationally funded

construction projects, including ones at Chernobyl, that have significantly exceeded original cost estimates.

Cost Estimates to Construct the New Chernobyl Shelter Have Increased Since the Initial Estimate

Current cost estimates to complete the Chernobyl Shelter Project total $1.2 billion, which is higher than the preliminary estimate developed about 10 years ago. The 1997 project estimate of $758 million was prepared by international experts from Ukraine, the United States, Europe, and Japan to provide a target amount for the international pledging of funds. This estimate was preliminary because many project decisions that impact costs, such as the number of stabilization measures and the design for the new shelter, were not yet determined. This initial estimate also excluded certain cost factors—such as reserve funds to cover costs from project uncertainties and risks and the escalation of materials and labor prices.[18] When the PMU estimated the necessary reserve funds in 2003, these cost factors added $194 million to the project, bringing the total estimated cost to about $1.06 billion. The estimate also rose because some work tasks were added or expanded that had not been considered in the 1997 plan, such as the removal and replacement of the vent stack adjacent to the existing shelter and expanding the PMU's role through the end of the project.

The estimate for total project costs was increased to $1.2 billion in 2006 by the PMU primarily because the estimate had to be reconciled with the higher-than-expected bids submitted by the two competing contractors in late 2005. The lower of the two bids for the new shelter contract—about $505 million—was about $163 million higher than the project's 2003 estimate for this work. In responding to contributors' requests for an explanation of the increase, EBRD officials said that prior cost estimates were based on the best available data at that time.

A PMU cost analysis indicated that the higher-than-expected contractor bid was mainly attributable to the effect of price escalations and different proposed methods for constructing the shelter. First, the analysis indicated that almost half of the $163 million increase was due to increases in material, labor, and other costs that had occurred between 2003 and mid-2005 or were anticipated through the project's completion. In

[18]The 1997 estimate did include an amount to partially account for project uncertainties. However, it did not identify an amount for cost contingencies specifically related to the construction of the new shelter.

particular, large price increases in steel and Ukrainian labor—the latter costs having roughly tripled between 2003 and 2006—contributed significantly to the increase in estimated costs. Second, roughly another $50 million in costs was attributable to construction approaches in the bid proposal that were different from those assumed in the conceptual design. For example, the bid proposal's approach required more expensive construction equipment than had been included in the PMU's prior cost estimates. However, the rise in total project costs between 2003 and 2006 was moderated by reduced cost estimates for some other project tasks, including for stabilizing the existing shelter.

According to EBRD and PMU officials, accurately estimating costs is difficult because the most expensive component of the project—constructing the new shelter—has not begun. In general, project cost estimates become more precise as project designs that define contracted activities are finalized, bids from firms competing for the contracts are received, and a contract is awarded. As work under the contract progresses, the adequacy of reserve funds becomes known, which increases the level of certainty in project cost estimates until the work and contract are completed and final costs are known. In the case of the shelter project, a PMU official told us that completed and ongoing contracts account for less than one-third of the estimated project costs.[19] Consequently, most of the project's estimated costs hinge on future contracts. For example, the single most expensive future contract is for the final design and construction of the new shelter, currently estimated to cost about $505 million based on the lower of the two bids.

Even if the Chernobyl shelter construction contract is awarded based on this price, the final costs are uncertain because only about half of the estimated costs will be associated with a fixed-price contract. Under this fixed-price contract, the contractor is generally responsible for paying any higher-than-anticipated costs.[20] For the remaining contracted activities,

[19]The calculated proportion of cost estimates for completed and ongoing contracts is based on total direct project costs (that is, estimated project costs minus reserve funds of $161 million). The calculation also excludes $73 million of contributions that are outside of the Chernobyl Shelter Fund but are included in the overall project estimate of $1.2 billion. Specifically, these excluded amounts are Ukrainian in-kind contributions valued at about $61 million and about $12 million for U.S. and Canadian funded projects in the late 1990s.

[20]According to PMU officials, under the fixed-price portion of the new shelter contract, the contractor can claim reimbursements for additional costs beyond its bid under certain conditions, such as for delays or increased work scope that result from the other party's actions. Such claims would be accepted, denied, or negotiated down.

ChNPP bears some or all of the risk for paying for higher-than-anticipated costs through the Chernobyl Shelter Fund (CSF). Some of these costs will not be clarified until the final design is completed. For instance, the design will finalize specifications for the amounts of materials, such as the amount of steel and concrete needed for the new shelter and its foundation. Further, the final design will specify some types of equipment and materials, such as the material used for the new shelter's internal and external covering. Pricing for these materials at the time of procurement is less certain because, although prices are assumed to typically rise over time, the price can be increasing or decreasing at any particular time.

Estimates Are Likely to Increase Due to Continued Delays in Awarding the New Shelter Contract, and Additional Factors Could Also Increase the Costs to Complete the Project

The current cost estimate of $1.2 billion to complete the Chernobyl Shelter Project will likely increase because of the costs of the protracted delay in awarding the contract for the new shelter. In late 2006, a PMU official involved in estimating costs told us that he was fairly confident that the cost estimate of $1.2 billion would be sufficient to complete the project because it included reserve funds of $161 million. He expected these reserve funds would provide a sufficient buffer against the cost impacts of project uncertainties and escalating prices for materials and labor. Around that time, EBRD notified CSF contributors that costs were increasing with each day the construction contract was delayed. The bank indicated, however, that the delay had not yet affected the project's cost estimate, but the available reserve funds were being eroded. The same PMU official told us in March 2007 that, based on the protracted delay, the total project's cost estimate would likely need to be increased by tens of millions of dollars.

Also according to this PMU official, when the total cost estimate is revised after the new shelter contract is awarded, it will likely increase for the following three reasons:

- First, tens of millions of dollars will likely be needed to adjust the contract costs for price escalations that have occurred. The contracting process for the new shelter allows for adjusting costs to account for changing prices of materials, fuel, and labor, and those prices must be updated from the time of the bid submission in late 2005 to the time of contract award, expected in 2007.

- Second, the delay means a longer, and therefore a more costly, operation period for the PMU. For example, the western consultants in the PMU have been maintaining their staffing level recently in anticipation of the

new shelter contract being awarded. This staffing level costs about $1 million per month.

- Third, the delay in awarding the new shelter contract also delays other future project contracts and thereby raises their costs. Specifically, contracts totaling an estimated $59 million, which are primarily to support the deconstruction of the existing shelter after the new shelter is in place, will probably be delayed. According to the PMU official, delays are typically assumed to increase the estimated costs at an escalation rate of about 3 percent per year.

Furthermore, a number of risk factors could increase the costs of the Chernobyl Shelter Project. Many of these factors were identified by donors to the shelter fund and PMU officials. Whether these factors will result in increased project cost increases depends on whether the revised estimate contains sufficient reserve funds. For example, a 2005 analysis by the PMU estimated the most likely costs of almost twenty risks and uncertainties for the new shelter's design and construction, which resulted in adding reserves of $51 million to the current estimate. However, these risk estimates are based on experts' opinion of probable outcomes and can vary significantly from the project's actual experience.

The adequacy of the reserve funds also depends upon PMU officials' ability to successfully mitigate the cost impacts of these project uncertainties. PMU officials said they have a mitigation plan for identified risks. A former PMU official told us the amount of cost increases that could potentially be prevented could vary widely—from zero to perhaps $100 million, depending upon the PMU's ability to mitigate the risk. Mitigating project risks could be challenging, particularly for potential events that are outside of the PMU's direct control. For example, according to a PMU official, if Ukraine revises regulations to require the new shelter to meet higher earthquake or tornado standards, then the amount of steel required for the new shelter—and the associated costs—would increase.

Other possible risks that could increase project costs identified by CSF contributors and PMU officials include the following:

- Delays may occur in Ukrainian regulatory approval of the new shelter design.

- The price of steel, fuel, or labor might escalate faster than anticipated.

- The needed Ukrainian labor force may not be available in sufficient numbers. Past medical screening for workers in high radiation areas found about half were not in acceptable health due to smoking, bad diet, ulcers, or other medical reasons. Also, ChNPP will have to find additional dosimetrists, who measure radiation levels, for the construction of the new shelter.

- The Ukrainian labor force may not be available at the costs anticipated. PMU officials said the project has to pay premium wages to attract construction workers to the Chernobyl site because the workers prefer to work elsewhere and a building boom in Ukraine has heightened competition for workers with other employers.

- The contaminated site exacerbates the question of whether a sufficient number of qualified workers can be found. Workers at Chernobyl must be replaced when they reach an annual radiation exposure limit, as specified by radiation safety standards. Also, more workers than anticipated might be needed if a partial collapse of the existing shelter were to increase the level of radioactive contamination level at the site.

- Safety infractions by workers could delay the project. In 2005, for example, work was stopped when some workers were found to have internal radioactive contamination because they were breaking safety rules, such as smoking and eating in contaminated areas.

- Transporting about 1,500 workers to Chernobyl and processing their access to the work site could create possible choke points that could potentially delay work.

In addition, other risks and uncertainties associated with the Chernobyl shelter, although beyond the scope of the current project, could have long-term technical and cost implications. Specifically, while Ukraine has responsibility for remediating the large quantity of radioactive waste inside the destroyed reactor and maintaining the site, it is unclear whether Ukraine has the resources to complete these tasks. In the course of our technical evaluation of the Chernobyl Shelter Project, we identified several activities that will have to be addressed in the future—either by Ukraine or with continuing assistance from other countries. Specifically, we found the following:

- The planned new shelter is just one part of an overall effort to make the Chernobyl reactor site environmentally safe. The existing shelter and the remains of the destroyed reactor must be dismantled and decommissioned. Radioactive waste from the site will need to be placed in

both high-level and low-level storage locations. Until these facilities are built with sufficient capacity, waste—both liquid and solid—will have to be kept within the confines of the new shelter once it has been completed.

- Ukraine will be responsible for dismantling the shelter. However, the final design for the actual process for dismantling the existing shelter is not complete. Furthermore, processes for keeping the radioactive dust stable while the existing shelter is being dismantled and limiting the impact of removing the roof of the existing shelter, including possible radiation exposure, are only conceptual in nature. Ukrainian experts told us they are concerned that removing the roof could be risky in terms of the possible contamination levels present at the time. These experts also noted that the technical challenges they may face are not well known and the costs of completing this task cannot be well quantified at this time.

- Although dismantling the existing shelter will remove the important risk of the shelter collapsing, without a plan for dismantling and removing the waste from the site, the risk of collapse and release of radioactive materials will pass to the new shelter, which will be constructed to confine—not contain—radioactive material. The new shelter is designed to confine dust and keep the weather out, but it will not serve as a radiation shield.

The international commitment to Chernobyl may not end with the completion of the new shelter, and expansions of the project's scope could be costly. For example, two donor officials noted that Ukraine has regularly raised the issue of assistance in removing the radioactive fuel within the shelter. This task is not within the shelter project's scope, although the new shelter is intended to facilitate Ukraine's ability to remove it in the future. A 1996 study sponsored by the European Commission indicated that removing the radioactive fuel could increase estimated project costs by about 45 percent to 100 percent. In commenting on a draft of this report, State indicated its consistent position has been that the United States would not agree to a scope expansion for the Chernobyl Shelter Project.

In addition, although Ukraine has agreed to fund the deconstruction of the existing shelter, the donors are responsible for funding the deconstruction design, equipment, and a radiological waste processing building as part of the Chernobyl Shelter Project. However, the undetermined scope of the deconstruction effort impacts the needed size and cost of the radiological waste processing facility for packaging the radioactive waste. Furthermore, there is a potential that additional stabilization measures for

the existing shelter will have to be undertaken, which would raise costs. The Ukrainian regulatory agency approved the limited number of stabilization measures subject to the understanding that the new shelter would be completed on schedule, and therefore future delays in schedule may create the need to implement additional stabilization measures.

Other Internationally Funded Construction Projects Have Experienced Significant Cost Overruns

Officials from the United States, the European Commission, the United Kingdom, and Ukraine expressed concerns that the Chernobyl Shelter Project could follow the path of other internationally funded construction projects, including ones at Chernobyl, that experienced significant cost overruns. For example, a European Commission official told us it is common knowledge that all large-scale construction projects cost more than their original estimates. A United Kingdom official said he could not remember an internationally funded project that was completed under budget. Our own work in the area of large-scale construction projects bears out these concerns. For example, we have reported on the following recent instances of projects that have significantly exceeded cost estimates and experienced schedule delays and other construction-related problems:[21]

- In 2004, we found that DOE estimates to build fossil fuel plants in Russia to replace aging and unsafe plutonium production reactors were likely to significantly exceed original cost estimates, possibly by over $500 million.
- The United States has had difficulties with past major construction projects in Russia, such as the Chemical Weapons Disposal Facility at Shchuch'ye. Further, many of these projects have experienced dramatic cost increases, significant delays, or other major setbacks. At Shchuch'ye, for example, the estimated cost for the project increased from about $750 million to over $1 billion.
- DOE's costs to finish the partially constructed Chernobyl heat plant, which was needed to supply space heat to facilities to support the decommissioning of the other Chernobyl reactors, rose significantly. In 1997, based on a cost estimate from an earlier European Commission-

[21]GAO, *Nuclear Nonproliferation: DOE's Effort to Close Russia's Plutonium Production Reactors Faces Challenges, and Final Shutdown Is Uncertain*, GAO-04-662 (Washington, D.C.: June 4, 2004); *Weapons of Mass Destruction: Effort to Reduce Russian Arsenals May Cost More, Achieve Less Than Planned*, GAO/NSIAD-99-76 (Washington, D.C.: Apr. 13, 1999); and *Nuclear Safety: Concerns with the Continuing Operation of Soviet-Designed Nuclear Power Reactors*, GAO/RCED-00-97 (Washington, D.C.: Apr. 25, 2000).

sponsored study, DOE signed a cost-sharing agreement with Ukraine to complete the construction of the heat plant. The cost-sharing agreement stipulated that the United States would provide a maximum of $10.5 million to support the project. Subsequently, DOE found it necessary to conduct extensive project assessments to better estimate the total project's cost. Based on the assessments, DOE estimated the U.S. share of the heat plant project to be $29 million to $30 million—rather than the $10.5 million in the original agreement. Final U.S. costs were $32.5 million when the project was completed in 2001. According to the Pacific Northwest National Laboratory, which served as the project manager for the heat plant, its team had to overcome tremendous challenges to minimize schedule slippages and contain costs. The challenges included delays in design approvals by various Ukrainian agencies, delays in the purchase and delivery of various plant components, and less than aggressive support for the schedule by ChNPP.

Ukrainian officials' concern with cost overruns is based on their conclusions about problems with internationally funded projects at Chernobyl. According to the ChNPP director, the Ministry of Emergency Situations tasked him with identifying and eradicating the root causes of the cost overruns and schedule delays occurring with all of the Chernobyl projects. In addition to the shelter project, his subsequent analysis covered three ongoing internationally funded projects that support the decommissioning of reactor units one, two, and three. Table 1 indicates the international funding and purposes of the three other projects, as well as the ChNPP director's data on schedule delays and cost increases.

Table 1: ChNPP Director's Analysis of Schedule Delays and Cost Increases for Other Internationally Funded Construction Projects at Chernobyl, as of October 2006

Project	Source of international funding	Project's purpose	Initial completion date (current estimated date)	Increase from initial cost estimate to current cost
Interim spent fuel storage facility	Nuclear Safety Account administered by EBRD	To decommission reactor units one through three, spent nuclear fuel must be removed from them. The interim spent fuel storage facility provides a place to prepare the removed fuel assemblies for storage and store them for up to 100 years.	2003 (no earlier than 2010)	39 percent[a] ($85 million to $113 million; additional $150 million to $200 million may be needed to complete project)
Liquid radioactive waste treatment plant	Nuclear Safety Account administered by EBRD	To support decommissioning, this plant is intended to process liquid radioactive waste currently stored at Chernobyl. The processing prepares the liquid for storage by transforming it into solid waste.	2001 (2008)	87 percent ($22 million to 42 million)
Industrial complex for solid radioactive waste management	Program through the European Commission	Also to support decommissioning, this complex will serve to manage solid waste generated by reactor operations, such as radioactively contaminated metal, concrete, plastic, wood, and paper. It will include a solid waste retrieval facility, a solid waste processing plant, and a repository for the disposal of short-lived radioactive waste.	2004 (2008)	44 percent ($42 million to $61 million)

Source: ChNPP.

[a]This contract included both dollars and euros amounts. When we calculated it in only dollars using a 2006 exchange rate, the increase was 33 percent rather than the 39 percent indicated by the director's analysis. The differences may reflect the use of different exchange rates, which fluctuate over time.

The ChNPP director concluded that these projects shared a common flaw that led to delays and cost overruns—a contract combining design and construction. He said this type of contract can result in a project proceeding to construction with a faulty design that results in costly changes during construction. Another ChNPP official, who had served as the deputy project manager for the interim spent fuel storage project, told us that a French company did not staff the project with the needed experts to design the spent fuel storage facility. Moreover, to save time and costs,

building was begun before a final design was completed.[22] When the ChNPP officials questioned this strategy, the contractor replied that they should not be concerned because under the design and construct contract, the contractor had ultimate responsibility for the project's success. Although ChNPP officials were not provided with final design documents to review, they finally recognized design deficits in the facility being constructed. The contractor had designed the facility to hold mock fresh fuel rather than real spent fuel, which takes on different dimensions during use.

As a result of the design flaws built into the interim spent fuel storage facility, the project's estimated costs were about $28 million over its original budget when physical work was suspended in 2003. The facility—for which about $96 million has already been spent—is still not operational. According to the ChNPP director, another $150 million to $200 million is needed to modify or completely rebuild the facility. Figure 5 shows the incomplete spent fuel storage facility at Chernobyl.

[22]GAO has noted that this can be a risky strategy. We have reported on the construction of a nuclear waste treatment plant in the United States that similarly experienced high cost overruns because, among other things, construction was started before design and technology development was completed. The U.S. Department of Energy's project management guidance cautions that concurrent design and construction should only be used in limited situations, such as when work scope requirements are well defined, projects are not complex, and technical risks are limited. GAO, *Hanford Waste Treatment Plant: Contractor and DOE Management Problems Have Led to Higher Costs, Construction Delays, and Safety Concerns*, GAO-06-602T (Washington, D.C.: Apr. 6, 2006).

Figure 5: The Interim Spent Fuel Storage Facility at Chernobyl

Source: GAO.

The Chernobyl director told us he is concerned that the construction of the new shelter will experience the same cost increases and delays as the other Chernobyl projects. One reason for his concern is that the new shelter contract combines design and construction, as did the contracts for the other three projects. Moreover, he stated that some companies in the Novarka consortium are the same companies that failed to complete the other Chernobyl projects on time and within budget.

Although they acknowledge that the interim spent fuel storage facility project suffered from technical design flaws, insufficient project oversight, and rising costs, EBRD and PMU officials told us the new shelter contract was structured to avoid repeating these problems. According to the PMU managing director, the bidding consortiums have the technical capacity to successfully complete the project. The proposal evaluation committee reviewed qualifications and designated both bidding consortiums as technically qualified to fulfill the contract. Moreover, despite combining design and construction tasks, the new shelter contract requires the contractor to provide the full scope of the design before construction

begins, with the exception of some site preparation. ChNPP officials will review the design and either give preliminary approval or require it to be revised. After the ChNPP officials preliminarily accept the design, it will be sent to the Ukrainian regulators to determine whether it is compliant with Ukrainian laws, rules, and regulations. Only after the regulators authorize construction will ChNPP officials give approval to start construction. In addition, the contract includes some incentives for the contractor to minimize the new shelter's costs, such as optimizing the design to limit the amount of needed steel and concrete.

State Has No Direct Management Responsibilities for the Chernobyl Shelter Project but Has Played a Key Role in Providing Funding

State, which is the lead U.S. government agency for the Chernobyl Shelter Project, has no formal role in directly managing the project. In addition, State's ability to control the project's activities is restricted because all major decisions must be based on a consensus of the assembly of contributors. However, State has had a key role in funding the project, which may be more difficult in the future. Appropriations to the FREEDOM Support Act, which provide U.S. funding for the project, have been decreasing, and current pledges from all donor governments and interest earned on the CSF are insufficient to cover the current estimated cost of $1.2 billion. As a result, an additional request for funding by the donors is likely. Because some donor governments are not expected to increase their pledges beyond what they have already provided, the United States and other donors might be asked to contribute an even larger share of funds in the future. Even though costs have been increasing and the project is experiencing delays, State has not reported detailed information about the project's status and cost estimates to Congress.

The State Department Relies on EBRD to Oversee and Manage the Project

State does not have a direct management or oversight role on the project and, similar to other contributors, depends on EBRD to oversee and manage the CSF. State's role is defined by the international structure of the project that was agreed to by the donors at the beginning of the project. Responsibility for administering and overseeing the CSF was assigned to the EBRD in 1997 by the donors, limiting the United States and other donors' role. EBRD oversees and manages the project, as specified in bank rules for the CSF and bank agreements with Ukraine and ChNPP. Although the PMU has overall responsibility for day-to-day project management, the PMU regularly reports to EBRD on project progress and seeks its nonobjection for any decision or change that might impact the project's cost or schedule.

Although State does not directly oversee and manage the project, the agency seeks to exert influence, to the extent possible, as the lead U.S. representative to the assembly of contributors. The assembly is the formal interface between donor governments and the EBRD and provides the forum for receiving official updates on the status of the project and the CSF. The assembly also provides approval for contract awards, major funding allocations and transfers, and any changes to the CSF structure and rules. However, despite State's efforts, the assembly structure makes it difficult for State to exert greater control because, among other things, a consensus of the voting assembly members is required for all major decisions.

State also seeks to address Chernobyl shelter issues by monitoring developments that affect the project and works closely with the EBRD and other donor governments to try to anticipate and resolve issues affecting project performance. For example, State officials told us they provided critical leadership for encouraging donor support during the 2005 pledging event, and continue to work closely with EBRD and the other G-7 governments to support the project.

A key aspect of State's role is to support the allocation of U.S. funds to the CSF.[23] These funds are provided as a grant and do not contain any conditions on their use. The CSF rules prohibit donors from specifying how their governments' payments will be spent on the project. As a result, donor governments rely on EBRD to monitor project expenditures and ensure that the funds are used to support legitimate project objectives. In the view of State officials, the Chernobyl Shelter Project does not differ from other multilateral nuclear safety projects administered by EBRD. For example, State also donates funds to the multilateral nuclear safety account that provides funding to improve the safety of Soviet-designed nuclear reactors. That account is also administered by EBRD, and State officials told us they cannot place specific conditions on the use of the funds it provides. However, State officials told us that establishing benchmarks that would link any additional pledging of funds to specific progress in meeting the project's performance goals would be a useful

[23]Within State, the Office for U.S. Assistance for Europe and Eurasia has responsibility for determining the level of FREEDOM Support Act funding to CSF. To make funding decisions, that office coordinates with State's Office of Nuclear Energy, Safety and Security, which has responsibility for the policy and subject matter related to nuclear safety for the project and CSF and has the lead for U.S. representation in the assembly of contributors.

management tool. They also noted that the other major donor governments would have to concur and cooperate with such an approach for it to be successful.

Despite these limitations on its formal role in the project, State, in concert with the U.S. Embassy in Kyiv, has taken steps to try to keep the Chernobyl project moving forward. The U.S. Embassy plays a critical role in monitoring the SIP progress and takes a lead in working with the other major donor countries' embassies to engage Ukrainian officials in resolving project issues. Additionally, within the assembly of donors, State took the lead in identifying a strategy to mediate an impasse between EBRD and Ukraine over the next steps in awarding the contract for the new shelter. Specifically, at an October 2006 assembly meeting, State proposed the participation of four observers, including one selected by Ukraine, to monitor contract negotiations between the PMU and the Novarka consortium. This strategy, which was adopted by the assembly, was designed to allow the contracting process to proceed in accordance with EBRD procurement rules, while encouraging greater Ukrainian trust in the process and acceptance of its outcome.

Additional U.S. Funding Will Likely Be Requested to Complete the Project

Additional U.S. funding will likely be requested for completing the Chernobyl Shelter Project because of an existing funding shortfall and the likelihood of continued cost increases. According to a PMU analysis in late 2006, a funding gap of about $190 million existed between the total amount pledged by donors and the current $1.2 billion estimate to complete the Chernobyl Shelter Project. Furthermore, the estimated gap could change markedly because of the uncertainties in both the project's estimated final costs and the available CSF funds, according to EBRD and PMU officials.[24]

Typically, the donors have committed additional funding through formal funding conferences. To date, there have been three such conferences, and the United States has pledged funds at all three of these conferences. Table 2 shows the amounts pledged by the United States since the inception of the Chernobyl Shelter Project.

[24]This funding shortfall is the most current official estimate provided to us by PMU officials. However, PMU officials indicated that the estimated funding gap will fluctuate up and down with changes in such factors as exchange rates, interest earned on the CSF, and revised project cost estimates.

Table 2: U.S. Pledges to the Chernobyl Shelter Project

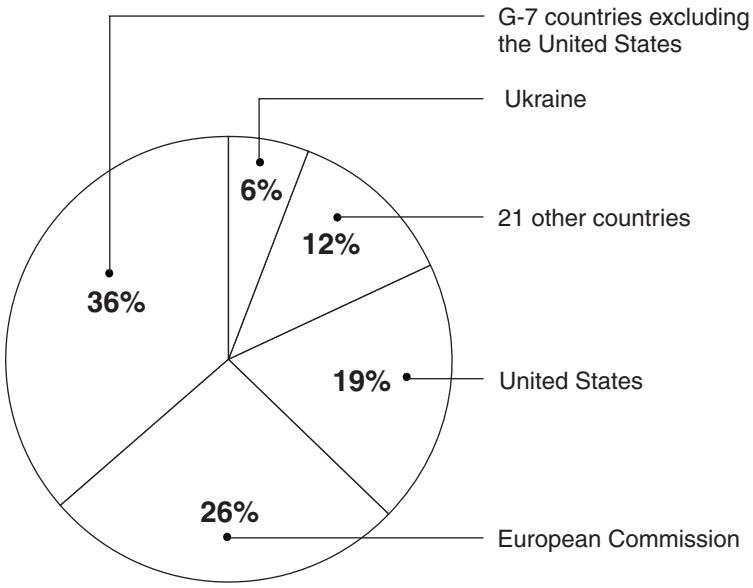
Year	Pledge amount (millions)
1997	$78
2000	$80
2005	$45
Total	**$203**

Source: State Department.

Regardless of the potential amount of additional funding needed to complete the project, the share of funding that will be requested from the United States and other donors will likely increase because some donors will not make any additional contributions. According to State, United Kingdom, and European Commission officials, donor representatives face a difficult task justifying to their governments further contributions because of the ongoing delays in awarding the new shelter contract, the lack of visible progress on the new shelter, and the lack of a firm estimate for project costs.

Officials from State and the United Kingdom also told us that they anticipate many donors may not have the resources—or may no longer be willing—to provide additional funds. Assuming the past patterns of donations shown in figure 6, the loss of funds from some or all the 21 governments with smaller shares of the contributions could reduce donations of additional funds up to 12 percent. If some G-7 countries or the European Commission also decide not to provide additional funding, then some of the remaining donors would have to provide contributions at a significantly higher level than their historic share. The signers of the 1995 memorandum of understanding regarding Chernobyl—the G-7 countries (the United States, Canada, Japan, France, Germany, Italy, and the United Kingdom), the European Commission, and Ukraine—have provided the bulk, about 88 percent, of the total funding for the Chernobyl Shelter Project. More specific data on the percentages of donor governments' contributions can be found in appendix III.

Figure 6: Chernobyl Project Contribution Agreements from the European Commission, United States, other G-7 countries, Ukraine, and 21 other countries, as of September 2006



Source: EBRD.

Notes: Ukraine's contribution includes both cash and in-kind contributions. Percentages do not total to 100 because of rounding.

Officials from State and the United Kingdom told us that donors might agree to provide additional funds if the prospects of the project's successful completion appear more certain. According to a United Kingdom official, his country would likely be willing to pledge more money, but only when (1) it has confidence in the project's cost estimates, which will not likely occur until the final design of the new shelter is complete; and (2) it can expect its contribution to be part of an international effort to pledge more. Similarly, a State official told us that additional funding would be easier to justify if the project was almost complete and only a small amount of additional funding were needed.

Ultimately, political considerations may play a large part in donor governments' decisions, including the United States', on whether to continue funding the project. For example, according to a United Kingdom official, donor governments want to avoid the negative political attention from not assisting Ukraine in completing this project. Further, he said that withdrawing support would be difficult for some governments whose support is part of a broader foreign policy objective.

Decreasing FREEDOM Support Act Funding Could Impact Future U.S. Contributions to the Chernobyl Shelter Project

To date, the United States has pledged $203 million to the CSF and has contributed about $154 million ($169 million adjusted for inflation) through 2006.[25] State officials currently plan to allocate about $20 million for each of fiscal years of 2007 and 2008 and $9 million for fiscal year 2009 to fulfill the remaining $49 million of the total $203 million U.S. commitment. These payments of $49 million may require State to reduce funding to other programs supported by the FREEDOM Support Act because funding under the act has been decreasing. Under the FREEDOM Support Act, State divides appropriations among many programs—including efforts to halt the proliferation of nuclear, biological, and chemical weapons—across the 12 countries covered by the law, including Ukraine. Further, according to State's foreign assistance coordinator for Ukraine, there is no alternative funding source for CSF other than the FREEDOM Support Act.

According to State officials, if the FREEDOM Support Act funds continue to decline and if additional pledges beyond the $203 million are requested, the United States could face three difficult funding options:

- Maintain Chernobyl Shelter Project funding using a larger proportion of the declining FREEDOM Support Act funds.
- Identify another funding stream. According to State officials, since they have not been able to identify any alternative existing fund source, State might have to approach Congress for a stand-alone appropriation to provide the funds.
- Determine that the United States will provide no further contributions beyond the $203 million pledged.

Since State may need to approach Congress for additional funding, Congress will need more information than currently provided. State does not provide Congress with detailed information on the project or its financial requirements. State officials told us the department does not notify Congress before pledging additional funds to the project but makes all pledges subject to the availability of funds through the congressional appropriations process. State does provide Congress with a brief statement about its continuing financial support for the shelter project in

[25]This contribution amount includes installment payments totaling about $142 million into the CSF and credit for an in-kind contribution of about $12 million, which DOE spent to improve the safety of the Chernobyl shelter.

its annual congressional budget justification for foreign assistance. For example, State's budget request documents for fiscal year 2007 state that a higher proportion of FREEDOM Support Act funds in fiscal year 2007 will go to the Chernobyl Shelter Project. Although USAID provides Congress with more detailed background and status information, its congressional notification memo is for the purpose of initiating a payment to the Chernobyl Shelter Fund and not for the purpose of identifying appropriation needs.

Conclusions

In our view, it is in the interest of all the major participants involved—including the United States—to see the Chernobyl Shelter Project completed as soon as possible. However, tensions—particularly between Ukrainian officials and EBRD representatives, and over the project's lack of progress, its potentially higher costs, and management difficulties—could result in further delays or even, in a worst case-scenario, the termination of the project. Therefore, it is incumbent upon all of the major participants to find a cooperative and constructive path forward. Failure to advance this project—given the condition of the existing shelter and the significant financial investment made by the United States and others—is neither desirable nor acceptable. We believe the United States—as the largest single-country donor to the project—has an important role to play in determining the outcome of the project. However, the U.S. financial commitment should not be open ended. Thus far, the United States has not placed conditions on the contributions made to the Chernobyl Shelter Fund—that is, specific benchmarks tied to tangible progress toward project completion—and it has not placed any caps or limitations on future funding levels. In our view, without a set of benchmarks linked to clearly defined project outcomes, the chances for project success are diminished and the United States is left without a clear idea of when, and at what cost, the Chernobyl shelter will be completed.

We are also concerned that donors' confidence in the cost estimates must be raised to ensure continued international support. Validations of major cost estimate revisions would be one way to increase the transparency of these estimates and donors' confidence in them. While we do not question the expertise of the analyses that have been done so far, it would seem reasonable to enlist the support of another organization—outside the Chernobyl management structure—to undertake an independent review. Given that EBRD has already contracted with outside audit groups to review project management issues, there is adequate precedent to pursue a similar course with respect to future cost revisions.

For over a decade, the United States has shown a strong financial commitment to completing the Chernobyl Shelter Project. However, total funds pledged are insufficient to meet the project's current cost estimates. Further, if additional money is needed—beyond the current $1.2 billion forecast to complete the project—State may need to find additional funding because funds provided by the FREEDOM Support Act have been diminishing. Moreover, the need to rely on additional U.S. funding to meet future shelter commitments may be exacerbated because of the uncertainties surrounding continued financial support from other donors. At the same time, the United States should consider the limits to its commitment if the project does not show significant progress and becomes excessively expensive. Assessing the project's progress and total costs will be important before committing additional funds beyond those already pledged, particularly after a more precise estimate of total costs is developed following the completion of the final new shelter design. As the project moves into the most expensive single task of constructing the new shelter, legitimate concerns about further schedule delays, cost increases, and funding gaps means that State needs to provide more accountability and transparency over U.S. contributions. To date, the information that State provides to Congress does not give a full accounting of the status of the project, including potential cost increases and delays. Since State may need to approach Congress for additional funding, Congress will need more information than currently provided through the department's annual congressional budget justification for foreign assistance.

Recommendations for Executive Action

To help ensure that the United States has a clear and consistent strategy—as well as a sound basis for continuing to support the Chernobyl Shelter Project—we recommend the Secretary of State, working in consultation with other contributors and EBRD, consider the following four actions:

- Establish specific performance benchmarks for the project that need to be met before additional pledges of funds are made in the future.
- Periodically review and revise the benchmarks to ensure they are relevant and applicable to the project's performance goals and time frames.
- Obtain an independent validation of major revisions to cost estimates.
- Develop a contingency strategy for obtaining the additional funding that may be needed to complete the project. The strategy should include encouraging other major donor countries and the European Commission to also contribute additional funding.

Furthermore, to increase State's accountability and transparency for funding the project, the Secretary of State should provide a detailed annual report to Congress about the status of the project, including project costs, project milestones, and estimated completion dates.

Agency Comments and Our Evaluation

We provided the Department of State and the U.S. Agency for International Development (USAID) with draft copies of this report for their review and comment. State's comments are presented as appendix IV and USAID's are presented as appendix V.

In their written comments, both State and USAID generally agreed with the draft report. Specifically, State noted that it provided useful insights into the complex history and management of the Chernobyl Shelter Project and acknowledged that devising a plan to meet a certain funding shortfall was needed. Furthermore, State generally agreed with our recommendations to help ensure that the United States has a clear and consistent strategy and a sound basis for continuing to support the Chernobyl Shelter Project. USAID concurred with our analysis that the project has experienced significant delays and may face potential cost increases.

However, both State and USAID raised some concerns about our recommendation that State—working in consultation with other contributors and the European Bank for Reconstruction and Development—establish specific benchmarks for the project that need to be met before additional funds are made available for the project. Both agencies asserted that linking the availability of additional funds to specific performance benchmarks requires careful consideration because it could lead to further project delays or increase costs. While recognizing that benchmarks could provide a useful management tool, State also noted that that the United States and other donors would need to evaluate whether the benefits offset the potential negative impacts. In addition, USAID asserted that our recommendation did not clearly identify which funds would be subject to the benchmarks.

We strongly believe that our recommendations regarding the establishment of performance benchmarks are prudent given the over 10-year history of the Chernobyl Shelter Project that has been marked by significant project delays and cost increases. In our view, performance benchmarks would introduce additional rigor and discipline into the Chernobyl Shelter Project, which can only help improve the project's

chances of success and reinforce contractor-related project milestones and schedules. We agree, however, with USAID's point that our recommendation should more clearly identify which funds should be subject to performance benchmarks. We have clarified the recommendation to indicate that additional pledges in the future should be benchmarked.

Although State concurred with our recommendation to obtain an independent validation of major revisions to cost estimates, it asserted that that the United States and other donors would need to determine if the benefits of this validation offset the potential delays and increased costs. We believe that an independent cost validation could strengthen donors' confidence that the project costs are realistic and achievable.

Although State agreed with our recommendation to provide a detailed report to the Congress about the status of the Chernobyl Shelter Project, it asserted that a two year reporting requirement—rather than an annual cycle—should be implemented. We believe that the Congress needs timely information about the project and think that an annual report would be the most appropriate mechanism to achieve this.

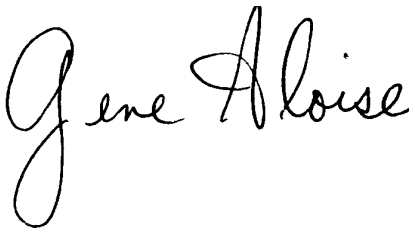
Finally, State provided two technical points in its written comments. First, State indicated its consistent position that the United States would not agree to a scope expansion for the Chernobyl Shelter Project. We have incorporated language in our report to reflect State's position. Second, State disputes our statement that the U.S. government costs for the Chernobyl heat plant rose significantly. As we note in the report, DOE entered into this initial agreement with Ukraine for a maximum U.S. contribution of $10.5 million. The final U.S. cost for the project totaled $32.5 million—a significant increase from the initial estimate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Secretary of State, the Acting Administrator of the Agency for International Development, interested congressional committees, and other interested parties. We will also make copies available to others on request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page

of this report. GAO staff who made major contributions to this report are listed in appendix VI.

Sincerely yours,



Gene Aloise
Director, Natural Resources
and Environment

Appendix I: An Analysis of the Chernobyl Nuclear Power Plant Accident

This appendix provides technical information about the root causes and impacts of the Chernobyl Nuclear Power Plant (ChNPP) accident that occurred in April 1986.

There is little controversy as to whether the accident at the unit four reactor of the Chernobyl Nuclear Power Plant on April 26, 1986, still stands as the worst nuclear accident in history. The exact reasons for the accident may not ever be fully known, as the primary source of evidence—the reactor itself— was destroyed, and the remaining evidence is still being interpreted. However, the failures that led to the explosion and resulting fire at the ChNPP unit four reactor fall into two categories: (1) system design weaknesses and (2) the numerous overrides of safety systems and violations of both written protocols and general principles, such as not operating a reactor outside of its licensed design parameters. Ironically, the accident at Chernobyl occurred outside normal operation of the reactor during a test designed to assess the reactor's safety margin in the event of a loss of electricity from the external power grid. The test protocol required less than full reactor power and was scheduled just prior to a routine shutdown of the reactor.

Nuclear Reactors

In most electric power plants, water is heated and converted into steam, which drives a turbine-generator to produce electricity. Fossil-fueled power plants produce heat by burning coal, oil, or natural gas. In a nuclear power plant, the fission[1] of uranium[2] atoms in the reactor provides the heat to produce steam for generating electricity.

Several commercial reactor designs are currently in use in the United States. The most widely used design consists of a heavy steel pressure vessel surrounding a reactor core.[3] The reactor core contains the uranium

[1]Fission is a nuclear reaction in which a nucleus is split into fragments, usually two pieces of comparable mass, accompanied by a release of energy.

[2]Uranium is a heavy metallic element that is naturally radioactive. It can be processed for use in research, nuclear fuels, and nuclear weapons. Its atomic number is 92, and it has 92 protons and 92 electrons. Uranium has several isotopes, the most abundant being U-238. However, U-235, as the fissile component of uranium, is the most important because it is usable as nuclear reactor fuel. U-235 is not very abundant and must be enriched for use in most nuclear power plants.

[3]The reactor core is the center of a nuclear reactor, and it contains the fuel that runs the reactor and the control elements.

fuel.[4] The fuel is in the form of cylindrical ceramic pellets about one-half inch in diameter that are sealed in long metal rods called fuel rods. The rods are arranged in groups to make a fuel assembly. A group of fuel assemblies forms the core of the reactor.

Heat is produced in a nuclear reactor when neutrons[5] strike uranium atoms and cause them to fission in a continuous chain reaction.[6] Control elements[7] made of materials that absorb neutrons, are placed among the fuel assemblies. When the control rods are pulled out of the core, more neutrons are available and the chain reaction speeds up, producing more heat. When they are inserted into the core, more neutrons are absorbed, and the chain reaction slows or stops, reducing the heat.

Most commercial nuclear reactors in the United States use ordinary water to slow down, or "moderate," the neutrons that maintain the fission process. These are called light water reactors. In this type of reactor, the chain reaction will not occur without the water to serve as a moderator. The water also serves to remove the heat created by the fission process. In the United States, two different light water reactor designs are currently in use, the Pressurized Water Reactor[8] and the Boiling Water Reactor.[9]

The nuclear fission reactors used in the United States for electric power production are classified as "light water reactors" in contrast to the "heavy water reactors" used in Canada. Light water (ordinary water) is used as the moderator in U.S. reactors as well as the cooling agent and the means

[4]Fuel is the fissionable material used in a nuclear reactor. It is contained in sealed fuel rods within the reactor core.

[5]Neutron is a neutral, or uncharged, particle that is stable when contained in the nucleus. It combines with protons, which are positively charged subatomic particles, to form the nucleus of nearly any given atom.

[6]Chain reaction is a nuclear reaction consisting of a self-sustaining series of fissions, in which the average number of neutrons produced exceeds the number absorbed or lost.

[7]A control element is a device used to control the power level of a nuclear reactor by absorbing neutrons and thereby controls the chain reaction taking place inside the reactor.

[8]Pressurized Water Reactor is a type of power producing reactor that keeps the water surrounding the core under pressure. When the pressurized water is heated by the reactor, it is sent to a heat exchanger, which boils water that is kept at a lower pressure. This steam is then sent to a turbine to generate electricity.

[9]Boiling Water Reactor is a type of power producing reactor that boils water directly in the core; steam is then sent to a turbine to generate electricity.

by which heat is removed to produce steam for turning the turbines of the electric generators. The use of ordinary water makes it necessary to do a certain amount of enrichment of the uranium fuel before the necessary criticality of the reactor can be maintained.

The Reactor Design

The ChNPP unit four reactor is a Soviet-designed RBMK (reactor bolshoy moshchnosty kanalny, or in English, high-power channel reactor). The RBMK is a pressurized water reactor with individual fuel channels that uses ordinary water (as opposed to heavy water) as its coolant and solid graphite (a form of carbon), a very pure form of the same graphite found in pencils, as its moderator. Its design is derived from the original reactor design of Enrico Fermi that initiated the first sustained and controlled nuclear fission chain reaction under Stagg Field at the University of Chicago on December 2, 1942. This use of a graphite moderator and water coolant is found in no other nuclear power reactors and makes the reactor unstable at low power levels, which greatly contributed to the unit four accident.

The RBMK reactors were favored by the former Soviet Union primarily because, in addition to producing both power (electricity and heat) and plutonium (as do all thermal fission reactors that have U-238 in their fuel matrix), they were able to be refueled while the reactor was still running and not shutdown. This ability was important to the Soviet Union's national security.

Fission reactors, including the RBMK at Chernobyl, contain fuel rods. Unit four at Chernobyl used zircaloy tubes 3.65 meters long filled with pellets of enriched uranium (U-235) oxide. The fuel rods were combined into cylindrical assemblies (10 meters long) in a carriage, 2 sets of 18 rods per assembly. To allow the reactor to be refueled while still operating, the assemblies could be physically put in and taken out of the reactor by a mechanical lift. These assemblies were in individual fuel channels, cooled by the pressurized water. The channels were within graphite blocks, which acted as the moderator. A moderator slows down fission neutrons, thereby allowing the fission chain reaction to continue. Also, mixed helium and nitrogen gas increased the graphite's heat transfer. Boron carbide control rods, which also absorb neutrons, were inserted into the core to (1) control the rate of fission; (2) maintain an even distribution of energy across the entire reactor; and (3) allow automatic, manual, and emergency control. Detectors inside the core monitored for any deviation from the reactor's normal operations and would indicate whether the control rods should be engaged to reduce or stop the fission reaction. Some of the

control rods would always be engaged during normal reactor operations. The entire reactor core is housed in the concrete reactor vessel that served as a radiation shield and had a steel pile cap that also supported the fuel assemblies.

All RBMK reactors, such as the ChNPP unit four, have a positive void coefficient, which results in the reactors being unstable at low power and having a tendency toward power surges. Other reactor designs have positive void coefficients as well, but they, unlike the RBMKs, have compensating design features to maintain stability. A void coefficient can occur in any water-cooled reactor. A void is a pocket of steam that forms in a water channel. The more steam that is created, the more voids that form; the more voids that form, the more the reactor operation varies, because steam is not an efficient coolant and can neither serve as a moderator nor neutron absorber. Water can serve all three functions: cooling, moderating, and neutron absorption. A positive void coefficient means that the excess steam increases power generation, and a negative void coefficient means that the excess steam decreases power generation. RBMK reactors have a high positive void coefficient; this means that the power generation can increase rapidly and, as a result, generate more steam, which in turn increases the power generation in an ultimately uncontrollable process. This process cycle can occur very quickly, as was seen at Chernobyl, where the reactor power peaked at a hundreds of times its normal, full-power rating. The reason for the high void coefficient in the RBMK reactors is that the moderator (graphite) and the coolant (water) are in separate channels. As the steam increases, the reactor gets hotter, but the moderator is unaffected by the steam, and the fission reaction continues. In fact, since the neutron-absorbing capacity of the water is an operating characteristic, the increased amount of steam increases the number of free neutrons, which increases the fission reaction.

Moreover, the graphite itself is a design weakness in that, while being more efficient for weapons making and a fairly effective moderator, it does not endure extreme temperatures very well. Graphite, which is carbon based, will burn in the core if it is exposed to air. If the graphite burns, the neutrons will hit at a greater velocity, causing more heat to be produced. Great care must be taken to keep air away from the core. Additionally, there was no containment vessel at the Chernobyl plant. In all U.S. nuclear power plants, there is a mandatory cement and steel reinforced containment “bubble” covering the core and other components. Unit four had a pressure seal designed to keep the pressure in, but no containment vessel in case of an explosion. Containment structures are intended to withstand and contain the energy and material released from a reactor

during an accident or incident. These materials could include radioactive gases (such as xenon and krypton), volatilized fission products and other elements, and solid material ejected from the core in the event of a full-scale core excursion. A core excursion could include, for example, a melt-down and loss of reactor vessel or primary system integrity.

Finally, as will be explained in the next section, there were errors in operating the reactor, including inadequate knowledge of the reactor characteristics, and ignorance or avoidance of operating regulations, beginning with the nonroutine operation of the reactor.

Safety Margin Test of the ChNPP Unit Four Reactor

Nuclear power plants need electricity. While the reactor generates power, the various systems that support the reactor operation need power from outside the plant. Thus, these systems need backup power in order to function should the outside power source be interrupted. Backup power can come from at least two sources: (1) the reactor itself can be used to provide this power and (2) backup generators can serve as an alternative power source. Problems arise if the reactor is not producing power—as was the case at Chernobyl, since it was in the process of routine shutdown—or if the time lag between power loss and generator startup is too long. The ChNPP safety margin test was designed to test this time lag. The reactor's power level was to be lowered to see whether the turbine itself would have enough residual inertia to pump coolant through the rector core, in combination with the existing coolant convection, until the backup generators started and provided electricity.

The test preparation sequence began almost 24 hours prior to the accident, at approximately 1 a.m. on April 25, 1986. The reactor's power level was gradually reduced to 1600 MW(t) by 2 p.m. the same day. This level was maintained until 11 p.m. During this period, the emergency core cooling system was isolated so that it would not interfere with the test. This did not directly contribute to the accident but could have reduced its impact. The power level was lowered again starting at midnight, April 26, and about 30 minutes later, the reactor was at 700 MW(t), which is now understood to be the minimum safe operating level for an RBMK due to the positive void coefficient. The reactor was then reduced to 500 MW(t), at which point, either due to human error or system failure, the reactor did not hold at its required level and dropped quickly to 30MW(t). In response, the operator tried to restore power by pulling out some of the control rods. Although it is not known exactly how many control rods remained in the reactor, there is general agreement that the number left was less than 26 and would have required the chief engineer's approval for continued

operation. By 1 a.m. on April 26, the reactor power was up to 200 MW(t). During the next 20 minutes, additional pumps were engaged to increase water flow to the reactor core, which decreased the water level in the steam separator. The automatic trip systems were disengaged in order to continue reactor operations. The feed water flow was increased to counter the problems in cooling. Some manual control rods were retracted, which may have reduced the number of control rods below the minimum effective number. The feed water flow was reduced to increase the steam separator water level, but this also decreased the core cooling, which caused steam generation in the core. All evidence suggests that the reactor indicators showed that it was stable, although in an abnormal operation state.

Thus, the actual test began at approximately 1:23 a.m. on April 26, 1986. The feed valves for the turbine were closed to make the turbine continue under its own inertia. Automatic control rods were lifted to counter the reduced reactivity due to the valve closures. This did not, however, decrease the volume of steam as expected. The steam generation increased, which, due to the positive void coefficient, increased power. The steam continued to increase unabated. The reactor operator engaged the control rods, which, due to their inefficient design, concentrated the reactivity in the bottom of the core. The reactor power rose to approximately two orders of magnitude greater than the reactor was designed for, which resulted in the fuel pellets fracturing, producing a pressure wave as the fragments reacted with the cooling water rupturing the fuel channels. This was followed by two explosions, the first of steam, and the second of fuel vapor that lifted the pile cap, introducing air that turned into carbon monoxide as it reacted with the graphite. Finally, the carbon monoxide ignited, starting a reactor fire. This entire sequence took approximately 24 hours; however, the time from test initiation to explosion took approximately 1 minute. The fire was eventually put out after tons of materials were dropped on the reactor and after many lives were lost.

Regarding the release of radionuclides, an International Atomic Energy Agency (IAEA) report has a sobering summary. The report noted that in the initial assessment of releases made by the Soviet scientists and presented at the IAEA Post-Accident Assessment Meeting in Vienna, it was estimated that 100 percent of the core inventory of the noble gases (xenon and krypton) was released. In addition, between 10 percent and 20 percent of the more volatile elements of iodine, tellurium and cesium were released as well. The early estimate for fuel material released to the environment was 3 percent, plus or minus 1.5 percent. This estimate was

later revised to 3.5 percent, plus or minus 0.5 percent. This corresponds to the emission of 6 tons of fragmented fuel.

According to IAEA, the accident resulted in more than 5 million people living in areas of Belarus, Russia, and Ukraine that are classified as "contaminated" with radionuclides (above 37 kBq[10] per square meter of cesium-137). Among them, about 400,000 people lived in more contaminated areas—classified by Soviet authorities as areas of strict radiation control (above 555 kBq per square meter of cesium-137).

There are wide-ranging estimates from various organizations about the death toll from the Chernobyl accident. According to IAEA, the World Health Organization, and Greenpeace, people did die at Chernobyl and people will continue to die from the effects of Chernobyl. This, when coupled with the vast contaminated areas of the former Soviet Union, makes Chernobyl the worst nuclear accident in history.

[10]A becquerel (Bq) is the international unit of radioactivity that equals one nuclear decay per second.

Appendix II: Objectives, Scope, and Methodology

This report (1) assesses progress in an internationally funded project to construct a new shelter over the damaged reactor at the Chernobyl Nuclear Power Plant in Ukraine and factors that impact the completion of its construction, (2) reviews the cost estimates to complete the project, and (3) assesses the U.S. role in overseeing the project and in funding it through the Chernobyl Shelter Fund (CSF).

To address these objectives, we conducted fieldwork in the United States and internationally. In the United States, we focused our review primarily on the Department of State (State) in Washington, D.C., since it is the lead U.S. agency for overseeing and funding the project. We also contacted officials and reviewed documentation from the U.S. Agency for International Development (USAID) in Washington, D.C., which administers the U.S. payments to the CSF. For historical and background perspectives, we met with officials from the U.S. Nuclear Regulatory Commission in Rockville, Maryland, and the Department of Energy in Washington, D.C., agencies which had more predominant roles in earlier phases of the Chernobyl Shelter Project. In addition, we coordinated with representatives from the U.S. Treasury Department, which is the federal agency that has oversight responsibilities for the European Bank for Reconstruction and Development (EBRD). EBRD, which is located in London, is a multilateral bank that, among other things, administers the CSF. We also met with officials from Bechtel International Systems in Frederick, Maryland, and Battelle Memorial Institute in Richland, Washington. These two organizations are part of a consortium of three western companies that provide staff to the project management unit (PMU) responsible for the day-to-day implementation of the Chernobyl shelter project.[1]

As part of our international fieldwork, during an October 2006 visit to London, we interviewed EBRD officials as well as the United Kingdom's representative to the assembly of contributors, a body that acts like a board of directors for the CSF. In June 2006, we met in Brussels, Belgium, with officials from the European Commission, which also has a representative on the assembly of contributors and is the single-largest contributor to the CSF. We also met with International Atomic Energy Agency (IAEA) officials in Vienna, Austria, to discuss the background of the project. In July 2006, we interviewed an official from Russia's Ministry

[1]The third western company in the consortium is Electricité de France, which is headquartered in France.

of Atomic Energy (Rosatom) to obtain Russia's views about the project. During October 2006, we met with current or former Ukrainian government officials in Kyiv, Slavutych, and the Chernobyl site in Ukraine. These officials represented the State Nuclear Regulatory Committee of Ukraine, the Ministry of Fuel and Energy, the Ministry of Emergency Situations, the Accounting Chamber of Ukraine, the Ministry of Foreign Affairs, and the Chernobyl Nuclear Power Plant (ChNPP). At the Chernobyl site, we observed the deteriorating existing shelter that is scheduled to be replaced and interviewed the ChNPP director and his managers, as well as PMU officials. In Kyiv, we also met with U.S. embassy officials, including the ambassador, an EBRD representative, and a contractor assisting the State Nuclear Regulatory Committee of Ukraine with regulatory reviews of project documents.

To examine the Chernobyl shelter project's progress toward completing the new shelter and factors impacting its completion, we reviewed various project documents and interviewed knowledgeable officials from EBRD, PMU, State, the United Kingdom, and the European Commission. Specifically, we obtained and reviewed 1997, 2003, and 2006 project schedules; EBRD's Project Progress Reports and other intermittent reports; PMU reports, including its 2005 analysis of risk areas for completing the new shelter; and the 2002 and 2005 independent audits of the PMU.

We generally had access to all needed information to assess the project's progress and factors impacting it. However, there were certain access limitations pertaining to our review of the delays related to the award of the new shelter construction contract. Since the contracting process is treated as confidential under EBRD procurement rules until the contract is awarded, we were not able to examine the bid proposal documents and their evaluations, the bid protest and its evaluation, or the open points in the bid proposal that were being negotiated during our work. However, we were able to examine relevant public documents related to the contracting process, such as the materials presented to the contractors to aid their preparation of proposals. Also, we were able to interview EBRD, PMU, Ukrainian, and State officials about the status of the ongoing contracting process.

To review the cost estimates to complete Chernobyl shelter project, we obtained cost estimate summaries and discussed these estimates with officials from EBRD, the PMU, and ChNPP as well as officials from State, USAID, Ukraine, the United Kingdom, and the European Commission. To examine the history of the project cost estimates, we obtained and

analyzed the original 1997 estimate developed by a team of international experts, PMU estimate summaries from 2003 to the present, and PMU reconciliations of estimates with prior ones. In March 2007, we requested and received from a PMU cost analyst an update on cost estimates, which provided information on the likelihood of a higher cost estimate as the result of delays in awarding the new shelter contract. In addition, we examined a 2005 PMU probability analysis that quantified the cost impact of about 20 risks for the construction of the new shelter. We also discussed the risk of further cost increases with PMU officials and CSF contributors. For the ChNPP director's cost analysis of three other internationally-funded Chernobyl projects, we confirmed the cost amounts either with an EBRD official or through a European Union document. We also reviewed GAO reports that provided examples of other internationally-funded construction projects that experienced significant cost overruns.

We judged that the project cost estimates were sufficiently reliable for the purposes of this report. We did not test the reliability of the price data used in the project cost estimates because we did not have access to the underlying data. However, we did judge that the cost estimating methodology used by the PMU analysts was reasonable. We reviewed the PMU's cost-estimating methodology using generally accepted cost-estimating principles[2] and discussed the methodology and the analyses with PMU officials responsible for developing the cost estimates. On this basis, we believe that Bechtel's estimates are sufficiently reliable for the purposes of this report as estimates of the project's potential cost. Further, we did not assess the project cost estimates' accuracy, which can only be definitively determined in the future after final project costs are known. However, we note in the report that the cost estimates may diverge from the project's final costs due to price escalations of materials and potential project risks, among other factors.

To assess the U.S. role in overseeing and funding the project, we interviewed State and USAID officials and obtained and analyzed documentation from them. In addition, we examined EBRD's CSF rules, its most recent *Project Progress Report* with CSF financial data, and other bank and PMU documents that described the roles of EBRD or the assembly of contributors. We also discussed the roles of contributors with

[2]For example, see Construction Management Association of America Inc., *Construction Management Standards of Practice*, (McLean, Va.: 2002).

assembly representatives from the United Kingdom and the European Commission. To examine State's efforts to monitor the project, we reviewed pertinent cables and related documents exchanged between State representatives in Washington, D.C., and U.S. embassy officials in Ukraine. Finally, to understand the information about the shelter project provided to Congress, we reviewed State's annual congressional budget justifications for foreign assistance and USAID's most recent congressional notification of payments to CSF.

In the report, we present CSF financial information as of September 30, 2006, in U.S. dollars. Because the EBRD reports CSF amounts in euros, we converted these amounts into U.S. dollars using the average exchange rate for the third quarter of 2006, as reported by the International Monetary Fund. We used the third quarter of 2006 because the most recent EBRD report cites CSF financial information that falls within that period. This adjustment may not account for relative price changes between the date on which countries made their contributions and the third quarter 2006. However, to provide an inflation-adjusted amount for the total U.S. contribution, we adjusted the U.S. contributions that occurred in different years for inflation using a gross domestic product price index, with a base year of 2006 (third quarter). This adjustment makes the U.S. contributions from different years comparable in terms of purchasing power.

To present the portions of contributions from the United States and other fund providers, we calculated percentages based on EBRD's data for contribution agreements in euros as of September 30, 2006. In addition to payments, contributions agreements may include formal commitment of funds that have not yet been paid into the CSF. For example, the U.S. commitment agreement amount, which totaled about $154 million in nominal dollars, included about $34 million that the United States had formally committed for payment to EBRD but had not yet paid. In contrast, the contributions agreement amounts exclude pledges to the CSF that have not been formalized. For instance, the United States' 2005 pledge of $45 million is excluded from the contribution agreement amount because it had not yet been formally committed for payment. Finally, some reported contribution amounts are affected by CSF accounting rules, which require contributions in non-euro currencies to be recorded in euro equivalents at historic exchange rates. The dollar amount of the U.S. commitment agreement was thus recorded in euros at a single historic exchange rate, regardless of exchange rates at the time of past or pending

U.S. payments.[3] According to an EBRD official, this reporting of the financial data is in line with the provisions of the CSF rules and provides the most accurate overview of donor commitments at any given time.

To assess the reliability of the project fund data for the purposes of this report, we reviewed the required CSF financial controls and two external audits of the fund. CSF rules require certain control mechanisms for accounting for the funds. Specifically, the assembly of contributors should approve the annual budget and financial statements of the fund, and the financial statements of the fund should be audited by internal and external auditors of EBRD. It was not our objective to—and we did not—audit the completeness or accuracy of CSF financial statements. However, we examined the external auditor's reports for 2003 and 2004 and found that both expressed the opinion that the financial statements were fairly presented and properly prepared. In addition, we corroborated the amount of U.S. contributions to CSF presented in EBRD data by confirming it with officials at State and USAID and reviewing USAID payment documentation. For these reasons, we believe the fund data is sufficiently reliable for the purposes of this report.

In the report, we describe Ukrainian laws based on secondary documents, officials' descriptions, or translated copies. However, we did not independently verify descriptions of Ukrainian law.

We performed our review from May 2006 through June 2007 in accordance with generally accepted government auditing standards.

[3]Outside of the recording procedure for CSF contribution agreements, payments into CSF are recorded at the exchange rate at the day of receipt.

Appendix III: Donor Governments' Contribution Agreements with the Chernobyl Shelter Project, as of September 2006

Donor governments	Percentage of total contributions
European Commission	26.30
United States	19.16
Other G-7 countries	35.97
Germany	8.35
United Kingdom	6.57
Japan	5.91
France	5.77
Canada	4.82
Italy	4.55
Ukraine	6.22
Total European Commission, United States, other G-7 countries, and Ukraine	**87.65**
Other countries	**12.35**
Switzerland	1.29
Russian Federation	1.24
Ireland	1.11
Austria	1.04
Norway	0.96
Sweden	0.92
Netherlands	0.79
Kuwait	0.75
Spain	0.70
Greece	0.69
Denmark	0.69
Finland	0.62
Belgium	0.43
Luxembourg	0.35
Poland	0.35
Slovak Republic	0.28
Korea	0.05
Slovenia	0.04
Israel	0.04
Portugal	0.02
Iceland	0.00[a]

Donor governments	Percentage of total contributions
Total, European Commission, United States, other G-7 countries, Ukraine, and other countries	**100.00**

Source: EBRD.

Note: The percentages exclude pledges that are not officially confirmed. The shares are also impacted by the CSF rules to account for pledges in non-euro currencies using set historic exchange rates.

[a]Less than .005 percent.

Appendix IV: Comments from the Department of State

United States Department of State

Assistant Secretary for Resource Management and Chief Financial Officer

Washington, D.C. 20520

JUN 25 2007

Ms. Jacquelyn Williams-Bridgers
Managing Director
International Affairs and Trade
Government Accountability 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 SAFETY: Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties," GAO Job Code 360693.

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 Andrew Sowder, Physical Scientist, Bureau of International Security and Nonproliferation, at (202) 736-4431.

Sincerely,

Bradford R. Higgins

cc: GAO – Terry Hanford
ISN – John C. Rood
State/OIG – Mark Duda

Department of State Comments on GAO Draft Report

NUCLEAR SAFETY: Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties
(GA0-07-923, GAO Code 360693)

The Department of State appreciates the opportunity to review and comment on the Government Accountability Office draft report entitled, "*NUCLEAR SAFETY: Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties*." The report is generally accurate and informative and provides useful insights into the complex history and management of the Chernobyl Shelter project.

The Department agrees for the most part with the recommendations made in the GAO draft report, which include five actions. However, as the report itself recognizes, Department consideration of the recommended actions must take into account the special role of the European Bank for Reconstruction and Development (EBRD) as the Chernobyl Shelter Fund (CSF) administrator and the Rules of the CSF, which govern the administration of the Fund by the EBRD and the participation of the United States and other donors represented on the CSF Assembly.

Department Response to Draft Report Recommendations

Recommendation 1: Establish specific performance benchmarks for the project that need to be met before additional funds are made available;

Recommendation 2: Periodically review and revise the benchmarks to ensure they are relevant and applicable to the project's performance goals and timeframes;

State Response: Partially concur. While benchmarks and the associated reviews could provide useful management tools, the incorporation of these additional requirements into the existing cumbersome Chernobyl Shelter Fund structure could have negative impacts on the EBRD, Project Management Unit (PMU), and contractor performance. Also, unilateral application of conditions or constraints on additional pledges could be negatively received by the other contributors to the CSF. Other major

donor governments would have to concur and cooperate with such an approach for it to be successful. The implementation of these steps could require third-party consultant resources that would incur costs and could result in delays to the project. The U.S. and other donors would need to evaluate whether the benefits of these control steps offset the potential negative impacts. It should also be noted that upon completion of the final design of the new Shelter, the contractor will have identified all major project construction milestones and critical path items, and accordingly, the PMU would be expected to impose appropriate project controls for performance-based payments.

Recommendation 3: Obtain an independent validation of major revisions to cost estimates;

State Response: Partially concur. As with Recommendations 1 and 2, the Department agrees in principle with the GAO recommendation for independent validation of major revisions to cost estimates. However, as with Recommendations 1 and 2, the Department cautions that the insertion of another review step could introduce substantial delays to an already burdensome project management process, especially if concurrence from the CSF Assembly would be required. A credible independent validation will require experts with multidiscipline experience in areas such as cost estimation, project controls, engineering, risk analysis, etc., and would incur costs associated with the requisite third-party consultant resources. Such an approach to this multinational project would require the approval of the CSF Assembly and would also need to be consistent with EBRD and CSF rules. Also, it is not clear that independent validation would improve the cost estimates, as validation alone will not change the uncertainties or address the difficulties in quantifying those uncertainties. As the GAO draft report states:

> "In general, project costs estimates become more precise as project designs that define contracted activities are finalized, bids from firms competing for the contracts are received, and then a contract is awarded. As work under the contract progresses, the adequacy of reserve funds becomes known, which increases the level of certainty in project cost estimates until the work and contract are completed and final costs are known."

The U.S. and other donors would need to determine if the benefits of such a requirement offset the potential delays and increased costs of the project that would likely result.

Recommendation 4: Develop a contingency strategy for obtaining the additional funding that may be needed to complete the project. The strategy should include encouraging other major donor countries and the European Commission to also contribute additional funding;

State Response: Concur. As indicated above, project costs will become more precise when project designs and contract terms are finalized. Once contract terms are final and contract costs have been explained to the CSF Assembly, the Department will consult with key Congressional Committees and devise a plan to meet what is certain to be a funding shortfall. That shortfall will have to be addressed on a multilateral basis, and we would insist that other donors pay their share. The United States has historically played a leadership role in encouraging broad international support for the CSF at the three pledging events held in 1997, 2000, and 2005. Given the Department's prominent role as the U.S. representative to the CSF Assembly and the relevant G-8 working group in which Chernobyl Shelter matters are addressed, the Department would also seek broad support among the G-8, European Commission, and other major donor countries should the need for additional funding for the Shelter arise in the future as the project nears completion.

Recommendation 5: Furthermore, to increase State's accountability and transparency for funding the project, the Secretary of State should provide a detailed annual report to Congress about the status of the project, including project costs, project milestones, and estimated completion dates.

State Response: Concur in principle. The Department is willing, as in the past, to provide Congress the information needed to support ongoing and potential future funding for the CSF. If requested, the Department will forward a report to the Congress based on information from the EBRD and information that the Department gathers through other channels including Department and Embassy Kyiv meetings with officials from the EBRD, the PMU, and the Government of Ukraine, as well as visits to the Chernobyl Nuclear Power Plant. A biennial (two-year) reporting frequency may be more appropriate for such a report.

Additional Substantive Comments

Expansion of Shelter Implementation Plan (SIP) Scope: In several places, the GAO draft report observes that PMU officials and representatives from donor governments indicated that "... the international commitment to Chernobyl may not end with the completion of the new shelter, and expansions of the project's scope could be costly."

State Response: The Department has consistently advanced the U.S. position that the Shelter Implementation Plan (SIP) scope should remain limited in order to limit cost increases and to ensure the maximum likelihood of project completion. Any scope expansion for the SIP would require the non-objection of the CSF Assembly, and the U.S. would not agree to such an expansion.

Characterization of the Chernobyl Heat Plant Project: The GAO draft report notes that, "DOE's costs to finish the partially constructed Chernobyl heat plant, which was needed to supply space heat to facilities to support the decommissioning of the Chernobyl reactors rose significantly."

State Response: The United States Government costs for this project, met through funds authorized under the FREEDOM Support Act, did not increase significantly. Based on an earlier European Commission's cost estimate, DOE only conditionally committed to provide $10.5 million for the facility provided the design was adequate and the facility could be commissioned. Immediately following the agreement with Chernobyl Nuclear Power Plant, DOE developed detailed cost and schedule baselines, which were very closely adhered to for the facility commissioning. While there were challenges in completing the heat plant, the first donor-funded construction project at the Chernobyl industrial site, the facility was completed with minimum impact on cost and schedule. The heat plant is the only donor funded project that has been completed at the Chernobyl industrial site and has successfully operated for the past six years. This project represents a tangible success achieved through the U.S. – Ukraine bilateral cooperation. The Chernobyl Plant management and Government of Ukraine officials highlight this facility as an example of a "success" and of how the projects should be managed and executed at the Chernobyl site.

Appendix V: Comments from the U.S. Agency for International Development

USAID
FROM THE AMERICAN PEOPLE

JUN 26 2007

Mr. Gene Aloise
Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Aloise:

I am pleased to provide the U.S. Agency for International Development's (USAID) formal response on the draft GAO report entitled Nuclear Safety: Construction of the Protective Shelter for the Chernobyl Nuclear Reactor Faces Schedule Delays, Potential Cost Increases, and Technical Uncertainties (July 2007) (07-923).

USAID concurs with the report's analysis that the Chernobyl Shelter project has experienced significant delays and may face potential cost increases. USAID, therefore, believes it is critical for the United States and other contributors to the Chernobyl Shelter Fund (CSF) at the European Bank for Reconstruction and Development (EBRD) to monitor closely the construction progress of the New Safe Containment (NSC) against clear milestones and to be prepared to consider, in consultation with other contributors and the EBRD, appropriate actions if project milestones are not being met.

Your report recommends benchmarks for conditioning the release of funds. However, we are concerned that imposing new decision-making processes on the Assembly of Contributors may hinder and further delay contract implementation. Since we expect that the large $500 million contract for the construction of the NSC will have performance benchmarks and legal processes for resolving disputes between the Chernobyl Power Plant and the contractor, our opinion is that the issue of additional benchmarks would require careful consideration. GAO's recommendation regarding benchmarks is not clear as to which funds releases they would apply to, when they would be reviewed, and what would be their relationship with the contractual performance benchmarks and the formal Assembly disbursement procedures.

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
www.usaid.gov

In addition to ensuring that project milestones are clearly defined and transparent, USAID views improved reporting by the EBRD to the Assembly on contract implementation and other project issues to be a high priority for effective project oversight and monitoring. GAO's report could be strengthened and clearer on the issue of the adequacy of reporting to the Assembly by the EBRD. Based on USAID's experience in attending Assembly meetings and reviewing progress reports to date, USAID is of the opinion that the EBRD-issued reports are not sufficient to closely monitor progress during this key construction phase. More comprehensive reports should be provided to the Assembly to enhance accountability and transparency and to minimize the need for external review and audit processes. As GAO confirmed during its investigation, detailed information is available from the Project Management Unit in the field that could be incorporated into these more extensive reports.

On the issue of potential cost increases, it is clear that large international infrastructure projects are experiencing increased costs, due to higher material, labor, and energy costs. Yet it may be worthwhile to note that selected on-going and completed CSP projects have been carried out within budget. With respect to the issue of potential additional funding requirements, we believe that the significant improvements in the economic conditions in Ukraine and Russia since the CSF agreement was signed suggest that these countries should be in a position to contribute a larger share of any new funding commitments.

Thank you for the opportunity to respond to the GAO draft report and for the courtesies extended by your staff in the conduct of this review.

Sincerely,

Mosina H. Jordan
Counselor to the Agency

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the contact named above, Glen Levis (Assistant Director), John Delicath, Terry Hanford, Keith Rhodes (GAO's Chief Technologist), Mary Welch, and Jennifer Young made key contributions to this report. Others who made important contributions included Michael Armes, Doreen Eng, and Tim Guinane.

GAO's Mission

The Government Accountability Office, the audit, evaluation and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through GAO's Web site (www.gao.gov). Each weekday, GAO posts newly released reports, testimony, and correspondence on its Web site. To have GAO e-mail you a list of newly posted products every afternoon, go to www.gao.gov and select "Subscribe to Updates."

Order by Mail or Phone

The first copy of each printed report is free. Additional copies are $2 each. A check or money order should be made out to the Superintendent of Documents. GAO also accepts VISA and Mastercard. Orders for 100 or more copies mailed to a single address are discounted 25 percent. Orders should be sent to:

U.S. Government Accountability Office
441 G Street NW, Room LM
Washington, D.C. 20548

To order by Phone: Voice: (202) 512-6000
TDD: (202) 512-2537
Fax: (202) 512-6061

To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Web site: www.gao.gov/fraudnet/fraudnet.htm
E-mail: fraudnet@gao.gov
Automated answering system: (800) 424-5454 or (202) 512-7470

Congressional Relations

Gloria Jarmon, Managing Director, JarmonG@gao.gov (202) 512-4400
U.S. Government Accountability Office, 441 G Street NW, Room 7125
Washington, D.C. 20548

Public Affairs

Paul Anderson, Managing Director, AndersonP1@gao.gov (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, D.C. 20548