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Report to Congressional Committees

July 2004

URANIUM ENRICHMENT

Decontamination and Decommissioning Fund Is Insufficient to Cover Cleanup Costs

GAO-04-692

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Highlights

Highlights of GAO-04-692, a report to congressional committees

Why GAO Did This Study

Decontaminating and decommissioning the nation's uranium enrichment plants, which are contaminated with hazardous materials, will cost billions of dollars and could span decades. In 1992, the Energy Policy Act created the Uranium Enrichment Decontamination and Decommissioning Fund (Fund) to pay for the plants' cleanup and to reimburse licensees of active uranium and thorium processing sites for part of their cleanup costs.

This report discusses (1) what DOE has done to reduce the cleanup costs authorized by the Fund, and (2) the extent to which the Fund is sufficient to cover authorized activities.

What GAO Recommends

GAO recommends that the Congress consider reauthorizing the Fund for an additional 3 years and require DOE to reassess the Fund's sufficiency before it expires to determine if further extensions will be necessary. GAO also recommends that DOE develop plans for the Paducah and Portsmouth plants that identify the most probable time frames and costs for completing the cleanup. DOE generally agreed with our recommendations, but stated its reluctance to develop plans for the plants now. GAO believes that without these plans, DOE will be unable to develop a more precise cost estimate or reassess the Fund's sufficiency.

www.gao.gov/cgi-bin/getrpt?GAO-04-692.

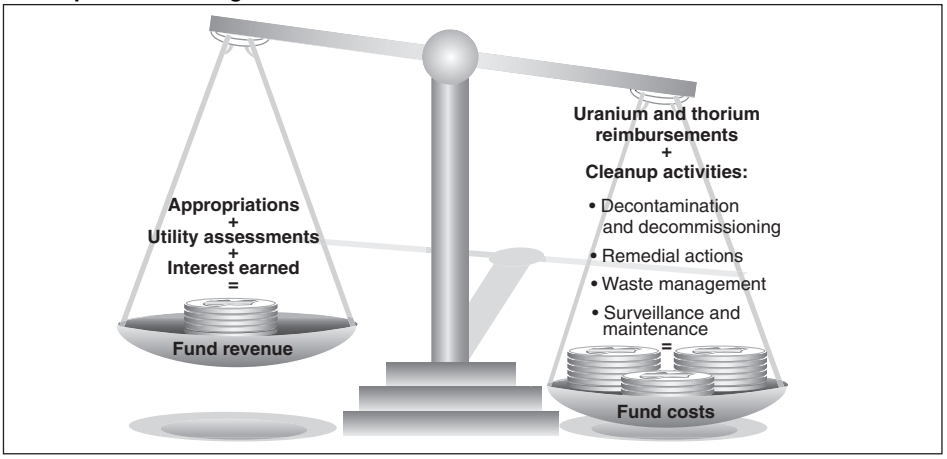
To view the full product, including the scope and methodology, click on the link above. For more information, contact Robin Nazarro at (202) 512-3841 or nazarror@gao.gov.

What GAO Found

The Department of Energy (DOE) has taken steps to reduce cleanup costs by taking actions that address recommendations made by the National Academy of Sciences and by pursuing an accelerated, risk-based cleanup strategy at the plants. In some cases, however, DOE has only partially addressed the Academy's recommendations. For example, one recommendation suggested that DOE develop three plans—namely, headquarters level, plant-complex level, and site level—that address and integrate the decontamination and decommissioning of the facilities. Only one plant has developed a plan, however. Additionally, DOE is pursuing an accelerated, risk-based cleanup strategy at the plants that it believes will reduce cleanup costs. According to DOE officials, an accelerated, risk-based strategy will accelerate time frames for cleanup, and establish "realistic cleanup criteria" in DOE's regulatory cleanup agreements.

Despite DOE efforts to reduce costs, we found that based on current projected costs and revenues, the Fund will be insufficient to cover the cleanup activities at the three plants. Specifically, our Baseline model demonstrated that by 2044, the most likely time frame for completing cleanup of the plants, costs will have exceeded revenues by $3.5 billion to $5.7 billion (in 2004 dollars). Importantly, we also found that the Fund would be insufficient irrespective of which model we used, including models that estimated the final decommissioning at the plants under (1) accelerated time frames, (2) deferred time frames, or (3) baseline time frames, and with additional revenues from federal government contributions as authorized under current law. Because the Paducah and Portsmouth plants are now estimated to cease operations by 2010 and 2006, respectively, extending the Fund by an additional 3 years would give DOE an opportunity to develop plans, including more precise cost estimates, for the cleanup of these plants and to better determine if further Fund extensions will be necessary.

Cleanup Costs Outweigh Fund Revenues



Source: GAO.

Contents

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended
D&D	decontamination and decommissioning
DOE	Department of Energy
RCRA	Resource Conservation and Recovery Act of 1976, as amended
USEC	United States Enrichment Corporation

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Accountability * Integrity * Reliability

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

July 2, 2004

Congressional Committees

Decontaminating and decommissioning the Department of Energy's three uranium enrichment plants—located near Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio—will cost billions of dollars and could span several decades. These plants, which encompass more than 30 million square feet of floor space, miles of interconnecting pipes, and thousands of acres of land, are contaminated with radioactive and hazardous materials. The Department of Energy's (DOE) Office of Environmental Management is responsible for cleanup of the three plants. Cleanup activities include assessing, treating, and disposing of the contamination found at the plants and the decontamination and decommissioning (D&D) of inactive facilities. DOE conducts its cleanup activities under the requirements of several federal environmental laws and compliance agreements with relevant regulatory authorities, including the Environmental Protection Agency and state regulatory agencies. While DOE estimates that all cleanup work at the Oak Ridge plant will be complete by 2008, the Paducah and Portsmouth plants may continue operations for the next several years,[1] and DOE has not determined when the final decontamination and decommissioning of these two plants will begin.

[1]In 2001, enrichment operations were ceased at the Portsmouth plant, but the plant was placed on cold standby—a status that maintains the plant in a usable condition.

In 1992, the Energy Policy Act, as amended,[2] established the Uranium Enrichment Decontamination and Decommissioning Fund (Fund) to pay for the cleanup of the three plants. The Fund also covers the reimbursement of a portion of the cleanup costs to licensees of active uranium and thorium[3] processing sites that previously sold these materials to the federal government. The Congress authorized annual contributions to the Fund for 15 years (ending in 2007), to be made by government appropriations and payments from domestic utility companies that utilized the enriched uranium produced by these plants for nuclear power generation. The Congress specified that any unused balances in the Fund be invested in Treasury securities and any interest earned be made available to pay for activities covered under the Fund. In creating the Fund, the Congress also required the National Academy of Sciences (Academy) to undertake a study to assess the opportunities for cost reduction in carrying out the D&D work at the three plants. In response, the Academy issued a report in 1996 that included 13 major recommendations to reduce D&D costs at the three plants.[4]

As directed by Public Law 107-222, we conducted a review of the sufficiency of the Fund. This report discusses (1) what actions DOE has taken to reduce the cleanup costs the Fund is authorized to support, and (2) the extent to which the Fund is sufficient to cover authorized activities.

To determine what actions DOE has taken to reduce the cleanup costs the Fund is authorized to support, we reviewed the National Academy of Sciences' report that identified major cost reduction recommendations for the nation's three uranium enrichment plants. We met with Academy officials to gain further information about the study, and with DOE and its contractor officials at each of the plants to determine the extent to which DOE has taken actions to address the recommendations. While we were able to obtain information on actions taken to date, DOE could not determine whether the actions were taken as a result of the Academy's recommendations. DOE was also generally unable to provide information

[2]All further references to the Energy Policy Act refer to the Energy Policy Act, as amended.

[3]Thorium is a naturally occurring, slightly radioactive metal that can be used as a nuclear fuel.

[4]National Academy of Sciences, *Affordable Cleanup? Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities* (Washington, D.C., 1996).

regarding the cost savings, if any, achieved by implementing these actions. To determine other steps DOE has taken to reduce cleanup costs, we visited all three plants and interviewed DOE and contractor officials from DOE headquarters, the Oak Ridge Operations Office, the Lexington Office, and the site offices at each of the three plants. Additionally, we obtained and analyzed documentation regarding DOE's accelerated cleanup strategy at the Oak Ridge and Paducah plants, as well as each of the three plants' draft risk-based end state vision documents, to better understand DOE's proposed options for consideration. We also interviewed regulatory authorities responsible for overseeing cleanup activities at the plants, including officials at the Environmental Protection Agency and state regulatory agencies in Kentucky, Ohio, and Tennessee.

To assess the sufficiency of the Fund to pay for the total projected costs of the Fund's authorized activities, we interviewed DOE and contractor officials responsible for the Fund's financial data and obtained DOE's current estimates for uranium and thorium reimbursement costs, the cleanup costs at the three plants, and the current and likely revenue projections. We assessed the reliability of this data and determined that the data were sufficient for the purposes of our report. We used the data to develop a number of simulation models that factored in the cost and revenue projections on an annual basis and uncertainties surrounding inflation rates, interest rates, costs, revenues, and the timing of the final D&D work at the Paducah and Portsmouth plants. See appendix I for a detailed description of our modeling methodology, assumptions, and results. We interviewed DOE and contractor officials from DOE Headquarters, the Oak Ridge Operations Office, the Lexington Office, and the site offices at each of the three plants, as well as officials from the federal and state regulatory offices party to the plants' cleanup agreements. We also toured the Oak Ridge plant to identify the major uncertainties that could impact future cleanup costs at the plants. Our scope and methodology are presented at the end of this report. We performed our work between September 2003 and March 2004 in accordance with generally accepted government auditing standards.

Results in Brief

DOE has attempted to reduce cleanup costs by taking actions consistent with recommendations made by the National Academy of Sciences (Academy) and by pursuing an accelerated, risk-based cleanup strategy at the three plants. DOE has adopted measures that address many of the Academy's recommendations, such as conducting focused technology demonstrations to improve the decontamination and decommissioning

process. However, in some cases, DOE has only partially addressed the Academy's recommendations. For example, one recommendation suggested that DOE develop three plans—namely, headquarters level, plant-complex level, and site level—that address and integrate the decontamination and decommissioning of the facilities, among other cleanup activities at the sites. DOE has not developed a headquarters-level or plant complex-level plan that addresses and integrates the decontamination and decommissioning of all three plants. Oak Ridge is the only plant with an agreed-upon decontamination and decommissioning plan. Additionally, DOE is pursuing an accelerated, risk-based cleanup strategy at the plants that it believes will reduce cleanup costs. According to DOE officials, an accelerated, risk-based strategy will accelerate time frames for cleanup at the Oak Ridge and Paducah plants, and establish "realistic cleanup criteria" in their regulatory cleanup agreements. By implementing cleanup actions more quickly and ensuring that its cleanup efforts are both cost effective and environmentally sound, DOE hopes it can avoid unnecessary costs while reducing risks posed to human health and the environment. However, some state and federal regulators have suggested that if DOE proposes changes to current cleanup agreements, renegotiating those agreements could delay cleanup and, therefore, potentially increase costs.

Despite DOE efforts to reduce costs, we found that based on current projected costs and revenues, the Fund will be insufficient to cover the activities authorized under the Fund. We determined that while the Fund is sufficient to cover reimbursements to uranium and thorium licensees, the Fund is insufficient to cover the complete cleanup at the three plants. Specifically, our Baseline model demonstrated that by 2044, the most likely time frame for completing all cleanup activities at the plants, cleanup costs will have exceeded revenues by $3.5 billion to $5.7 billion (in 2004 dollars). Importantly, we found that the Fund would be insufficient irrespective of what estimates were used, including models that estimated the final decommissioning at the plants under (1) accelerated time frames, (2) deferred time frames, or (3) baseline time frames, and with additional revenues from government contributions as authorized under current law. Further, until DOE has more specific information about such factors as the dates for beginning and completing the decommissioning work at the Paducah and Portsmouth plants, it is not possible to more precisely determine the total resources needed to cover the Fund's authorized activities. Because the Paducah and Portsmouth plants are now estimated to cease operations by 2010 and 2006, respectively, DOE should be able to develop plans, including more precise cost estimates, for the

decontamination and decommissioning of these plants. Extending the Fund by an additional 3 years would give DOE an opportunity to develop these plans and a better estimate of the costs to clean up the plants. With this information, DOE could better determine if further extensions to the Fund will be necessary.

In order to better ensure that the Fund will be sufficient to cover the projected costs for the authorized activities, we are recommending that the Congress consider reauthorizing the Fund for an additional 3 years to 2010, and require DOE to reassess the sufficiency of the Fund before the expiration date to determine if additional extensions will be necessary. To further reduce the uncertainty surrounding the sufficiency of the Fund, we are also recommending that the Secretary of Energy develop decontamination and decommissioning plans that would identify the most likely time frames for completing the final work at the Paducah and Portsmouth plants.

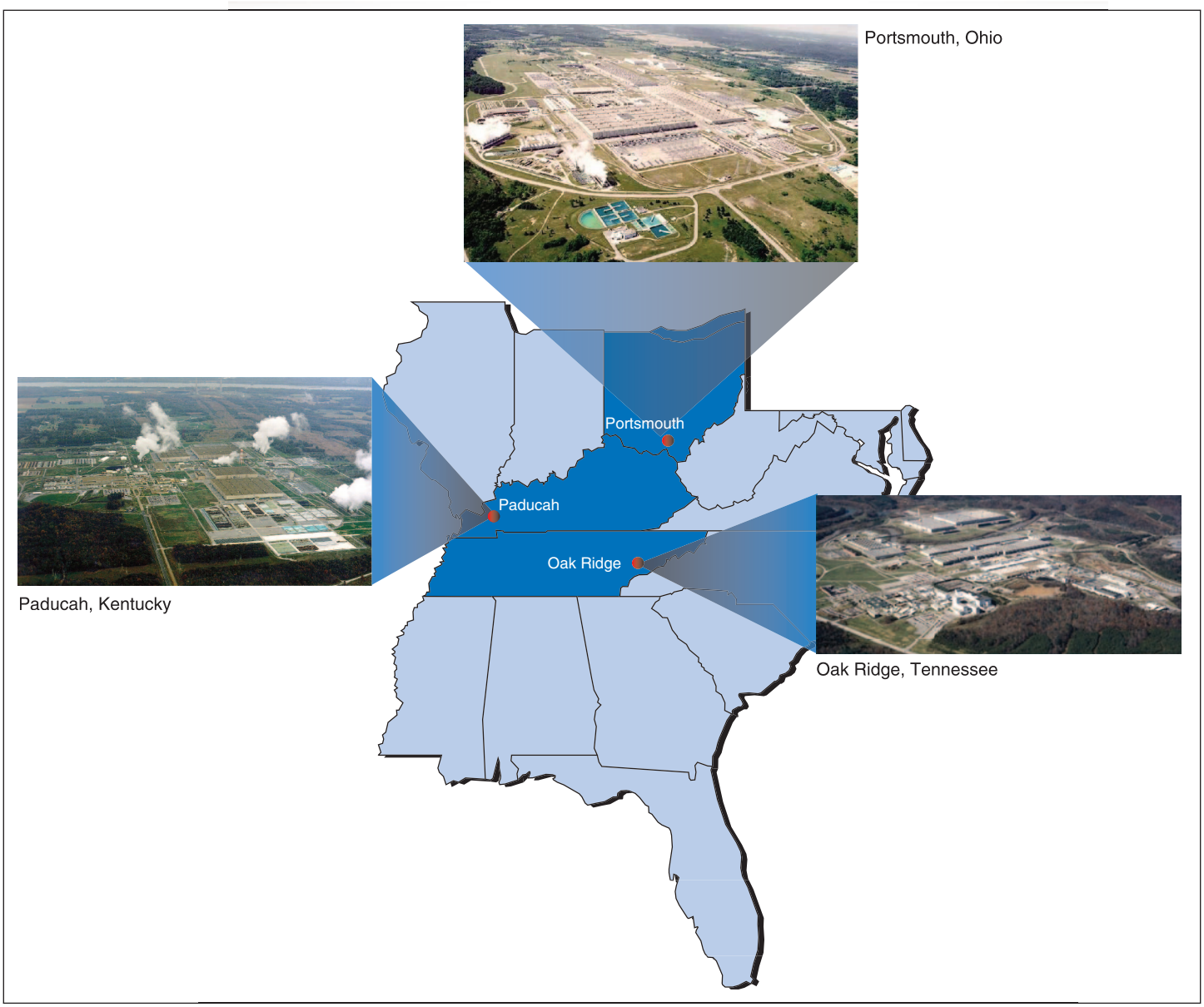
DOE generally agreed that our report accurately presents the current status of the Fund and concurred with our recommendations that the Congress consider reauthorizing the Fund for 3 additional years and require DOE to reassess the sufficiency of the Fund before it expires in 2010 to determine if additional extensions will be necessary. DOE also stated that it would develop decontamination and decommissioning plans for the remainder of the facilities at Paducah and Portsmouth "at the appropriate time," but did not specify a date. We believe that unless DOE develops decontamination and decommissioning plans that include the most probable time frames and costs for completing final work at Paducah and Portsmouth, DOE will not be able to develop a more precise estimate of the total funds necessary to cover the authorized cleanup activities or assess the Fund's sufficiency and determine if further extensions are necessary.

Background

The federal government has enriched uranium for use by commercial nuclear power plants and for defense-related purposes for more than 40 years at three plants located near Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio (see fig. 1). These uranium enrichment plants are largely obsolete, however, due to the emergence of newer, more efficient technologies and the globalization of the uranium enrichment market. DOE now faces the task of decontaminating, decommissioning, and undertaking other remedial actions[5] at these large and complex plants that are contaminated with hazardous industrial, chemical, nuclear, or radiological materials.

[5]Remedial actions refer to environmental cleanup activities directed at eliminating or reducing contaminate sources and contaminated soil and groundwater.

Figure 1: Location of the Three Uranium Enrichment Plants



Source: DOE.

In 1991, at the request of the House Subcommittee on Energy and Power, GAO analyzed the adequacy of a $500 million annual deposit into a fund to pay for the cost of cleanup at DOE's three uranium enrichment plants.[6] We reported that a $500 million deposit indexed to an inflation rate would likely be adequate, assuming that deposits would be made annually into the fund as long as cleanup costs were expected to be incurred, which at the time of the study was until 2040. Additionally, in a related report we concluded that the decommissioning costs at the plants should be paid by the beneficiaries of the services provided—in this case, DOE's commercial and governmental customers.[7]

In 1992, the Congress passed the Energy Policy Act, which established the Uranium Enrichment Decontamination and Decommissioning Fund (Fund) to pay for the costs of decontaminating and decommissioning the nation's three uranium enrichment plants. The Energy Policy Act also authorized the Fund to pay remedial action costs associated with the operation of the plants to the extent funds are available and to reimburse uranium and thorium licensees for the portion of their cleanup costs associated with the sale of these materials to the federal government. The Energy Policy Act authorized the collection of revenues for 15 years to pay for authorized cleanup costs. The revenues are derived from: (1) an assessment on domestic utilities of up to $150 million annually, based on a ratio of their purchases of enriched uranium to the total purchases from DOE, including those for defense; and (2) federal government appropriations for the difference between the authorized funding under the Energy Policy Act and the assessment on utilities.[8] In addition, the Energy Policy Act provided that balances in the Fund be invested in Treasury securities and any interest earned be made available to pay for activities covered under the Fund.

DOE's Office of Environmental Management is responsible for management of the Fund and cleanup activities at the three plants, which,

[6]U.S. General Accounting Office, *Uranium Enrichment: Analysis of Decontamination and Decommissioning Scenarios*, GAO/RCED-92-77BR (Washington, D.C.: Nov. 15, 1991).

[7]U.S. General Accounting Office, *Comments on Proposed Legislation to Restructure DOE's Uranium Enrichment Program*, GAO/T-RCED-92-14 (Washington, D.C.: Oct. 29, 1991).

[8]The following revenue amounts are authorized: $480 million for fiscal years 1992-1998; $488.3 million for fiscal years 1999-2001; and $518.2 million for fiscal years 2002-2007. Both domestic utility assessments and government appropriations are to be adjusted annually for increases in the Consumer Price Index.

through fiscal year 2003, were mostly carried out by its contractor, Bechtel Jacobs. The department's Oak Ridge Operations Office in Oak Ridge, Tennessee, had historically provided the day-to-day management of the Fund and oversight of the cleanup activities at all three uranium enrichment plants. However, in October 2003, DOE established a new office in Lexington, Kentucky, to directly manage the cleanup activities at the Paducah and Portsmouth plants. The Oak Ridge Operations Office continues to manage the Fund and the cleanup activities at the Oak Ridge plant.

Currently, the Fund is used to pay for the following activities:

- *Reimbursements to uranium and thorium licensees*. The Energy Policy Act provides that the Fund be used to reimburse licensees of active uranium and thorium processing sites for the portion of their decontamination and decommissioning activities, reclamation efforts, and other cleanup costs attributable to the uranium and thorium materials they sold to the federal government.[9]

[9]The Energy Policy Act authorizes reimbursements to uranium licensees not to exceed $350 million and reimbursements to the thorium licensee not to exceed $365 million for the portion of their cleanup costs associated with the sale of these materials to the federal government. The remaining unused authorized amounts are adjusted annually based upon the Consumer Price Index.

- *Cleanup activities at the three uranium enrichment plants.*[10] Cleanup activities at the plants include remedial actions, such as assessing and treating groundwater or soil contamination; waste management activities, such as disposing of contaminated materials; the surveillance and maintenance of the plants, such as providing security and making general repairs to keep the plants in a safe condition; the decontamination and decommissioning (D&D) of inactive facilities by either cleaning up the facilities so they could be reused or demolishing them; and other activities, such as litigation costs at the three plants and funding to support site-specific advisory boards.[11] See figure 2 for an example of the D&D process, including before, during, and after D&D work is complete at a facility.

[10]Cleanup activities are conducted under the requirements of the Resource Conservation and Recovery Act of 1976, as amended (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA); and compliance agreements with regulatory authorities, which include the Environmental Protection Agency and state regulatory agencies in Kentucky, Ohio, and Tennessee.

[11]There are additional activities being carried out at the uranium enrichment plants that are not currently paid for by the Fund. For example, the costs to dispose of each plant's depleted uranium hexafluoride (a byproduct of the uranium enrichment process) are currently paid for by a separate appropriation within DOE's budget. Some of these activities could be paid for by Fund resources in the future.

Figure 2: The Decontamination and Decommissioning Process

Before D&D. Fluorine storage facility at the Oak Ridge plant. Fluorine gas is a key component in the uranium enrichment process.

During D&D. Taking fluorine gas measurements prior to removal.

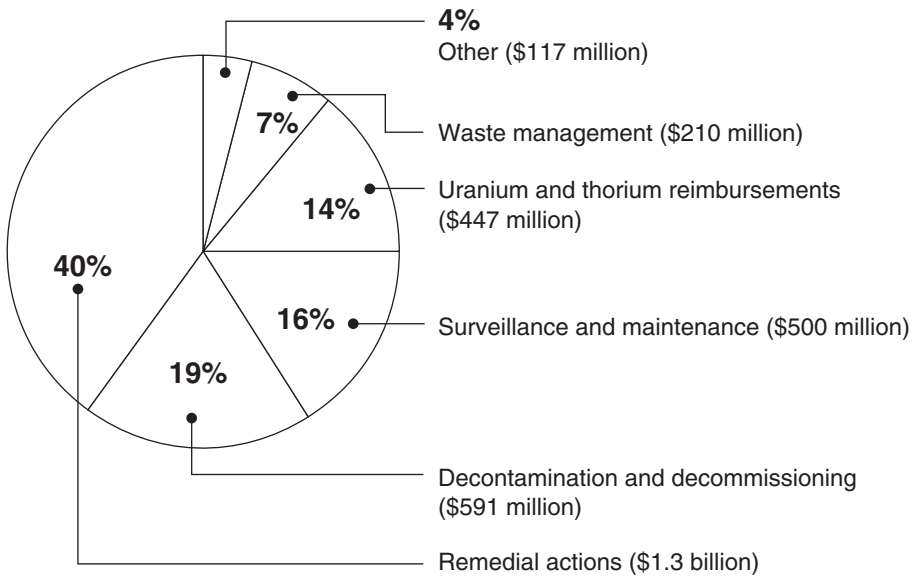
During D&D. Facility demolition nearing completion.

After D&D. Building rubble awaiting disposal.

Source: DOE.

From fiscal year 1994, when the Fund began incurring costs, through fiscal year 2003, a total of $3.2 billion (in 2004 dollars) from the Fund has been spent on the uranium and thorium reimbursement program and cleanup activities—remedial actions, waste management, surveillance and maintenance, decontaminating and decommissioning, and other activities—at the three uranium enrichment plants (see fig. 3).

Figure 3: Total Fund Expenditures, Fiscal Years 1994-2003



Source: GAO analysis of DOE data.

Note: Total Fund expenditures for fiscal years 1994 through 2003 were $3.2 billion, adjusted to fiscal year 2004 dollars.

The Oak Ridge uranium enrichment plant, known as the East Tennessee Technology Park, is located on 1,500 acres of land just outside of Oak Ridge, Tennessee. It is the oldest of the three plants and has not produced enriched uranium since 1985. According to DOE officials, while most of the remedial actions and D&D work remain, the majority of the key regulatory decision documents are in place and the agency is now positioned to begin implementing the cleanup work. DOE currently plans to complete all cleanup at the plant and close the site by the end of fiscal year 2008.

The Paducah plant, located on about 3,500 acres of land west of Paducah, Kentucky, continues to enrich uranium for commercial nuclear power plants under a lease to a private company, the United States Enrichment Corporation (USEC). According to USEC's director of communications, for planning purposes USEC assumes that the plant will continue operations until about 2010. Because the plant is still operating, DOE has initiated a limited amount of D&D. However, it is currently undertaking studies and implementing a series of remedial actions while the plant is in operation, and estimates that it will complete these actions by 2019. DOE has not yet

determined when it will begin D&D of the facilities currently in use (final D&D).

The Portsmouth plant, a 3,700-acre site located north of Portsmouth, Ohio, ceased enriching uranium in May 2001, due to reductions in the commercial market for enriched uranium. Later that year, the plant was placed on cold standby, so that production at the facility could be restarted in the event of a significant disruption in the nation's supply of enriched uranium.[12] Current plans call for maintaining the plant in cold standby until September 2006, though a recent DOE Inspector General's report found that DOE has not established a well-defined endpoint for the cold standby program and extensions to the program may be possible.[13] While D&D of the facilities currently on cold standby (final D&D) has not yet been initiated, DOE has been working on remedial actions at several contaminated areas. DOE has not yet determined when final D&D will begin at the Portsmouth plant.

DOE Has Taken Several Actions to Reduce Cleanup Costs

DOE has taken several steps to reduce cleanup costs by taking actions consistent with the National Academy of Sciences' (Academy) cost reduction recommendations and by pursuing an accelerated, risk-based cleanup strategy at the uranium enrichment plants. DOE has adopted measures that address most of the Academy's major cost recommendations, such as conducting focused technology demonstrations to improve the decontamination and decommissioning process. DOE is also pursuing an accelerated cleanup strategy at the Oak Ridge and Paducah plants to accelerate the time frames for conducting cleanup, which it expects will reduce operational costs. In addition, DOE is revisiting each plant's envisioned end state—the anticipated land use after the completion of cleanup efforts—to determine if cleanup at each of the plants is based on a technical risk assessment appropriate for the sites' future land use. According to DOE, this risk-based end state approach focuses DOE's environmental cleanup efforts in a way that is both cost effective and protective of human health and the environment. However, state and federal regulators have voiced concerns that if cleanup

[12]USEC was responsible for uranium enrichment before operations ceased and was awarded the contract to maintain the plant in cold standby condition.

[13]U.S. Department of Energy, Office of Inspector General, *Cold Standby Program at the Portsmouth Gaseous Diffusion Plant* (Washington, D.C., December 2003).

agreements must be renegotiated, the cleanup could be delayed and result in increased costs.

DOE Has Taken Actions That Address the National Academy of Sciences' Cost Reduction Recommendations

DOE has taken actions consistent with most of the 13 major cost reduction recommendations made by the Academy in its 1996 report on opportunities for D&D cost reductions at the three plants.[14] These recommendations suggested a variety of cost reduction measures, including developing specific technologies and suggestions for planning, management, and regulatory coordination. Table 1 shows the focus and status of the Academy's recommendations.

Table 1: Status of the Academy's Major Recommendations

		Status of recommendations		
Focus of recommendations	**Number of recommendations**	**Addressed**	**Partially addressed**	**Not applicable**
Management, including contract management, development of D&D strategic plans, and security	5	1	4	0
Development of D&D technologies	4	2	1	1
Regulatory coordination and stakeholder involvement	2	1	1	0
Recycling/waste disposal	2	2	0	0
Total	**13**	**6**	**6**	**1**

Source: GAO analysis of DOE information.

As table 1 shows, DOE took actions that address 6, or almost half, of the Academy's 13 recommendations. For example, the Academy recommended that DOE convert depleted uranium hexafluoride—a byproduct of the uranium enrichment process—to a more stable chemical form for storage or disposal. DOE recently awarded a contract to construct and operate conversion facilities at both Paducah and Portsmouth. In March 2004, DOE

[14]National Academy of Sciences, *Affordable Cleanup? Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities* (Washington, D.C., 1996).

began shipping the cylinders of depleted uranium hexafluoride stored at Oak Ridge to Portsmouth for conversion.

For another 6 recommendations, DOE took actions that partially implemented the recommendations—either initially taking actions that implemented the recommendation and then later modifying its approach, or taking actions that addressed only a portion of the recommendation or only one of the three plants. For example, the Academy recommended that DOE develop three plans—namely, headquarters level, plant-complex level, and site level—that address and integrate the D&D of the facilities, environmental remediation activities, and the management of depleted uranium hexafluoride. DOE has not developed a headquarters-level or plant complex-level D&D plan that addresses and integrates D&D of all three plants with other DOE activities. Oak Ridge is the only plant with an agreed-upon D&D plan that incorporates D&D, other cleanup activities, and the management of depleted uranium hexafluoride. The Paducah plant currently has a plan that lays out DOE's approach for a portion of its cleanup, but the plan does not address final D&D. DOE does not have a D&D plan for the Portsmouth plant. However, the DOE site manager said the agency is currently working to develop a Portsmouth strategic plan that will address final D&D, other cleanup activities, and management of depleted uranium hexafluoride.

DOE officials told us they have achieved cost savings as a result of the actions they have taken that address the Academy's recommendations. However, in most cases they were not able to quantify the cost savings achieved because the actions taken were either improvements to processes or procedures already in place or because they have not quantitatively evaluated the savings. For example, the Academy recommended that DOE consider the technical and management approaches successfully used for the D&D of the Capenhurst uranium enrichment plant in the United Kingdom. According to DOE officials, they considered the technical and management approaches used at both the Capenhurst plant and other U.S. D&D projects before beginning D&D efforts at Oak Ridge and have, in several cases, contracted with experienced environmental management contractors (who have participated in decommissioning activities at these sites) to take advantage of their expertise and knowledge. However, DOE has not quantitatively evaluated the financial savings from these efforts.

In one instance, DOE has not taken action to implement the Academy's recommendation because the recommendation made by the Academy is no longer applicable. The Academy recommended that DOE establish a modest research program to develop methods to decontaminate diffusion barrier material[15] effectively. According to DOE officials, such research is no longer needed because the material is placed into an on-site disposal facility, eliminating the need for decontamination. DOE has constructed an on-site disposal facility at Oak Ridge, and similar facilities are being considered for both Paducah and Portsmouth. Appendix II provides additional details on the Academy's recommendations and the actions that DOE has taken to address them.

[15]Diffusion barrier material is the material used to separate and enrich uranium during the enrichment process.

DOE Is Pursuing an Accelerated, Risk-Based Cleanup Strategy at the Plants to Reduce Costs

DOE is pursuing an accelerated cleanup strategy at the Oak Ridge and Paducah plants. Adopted after a 2002 review of DOE's environmental management program found that only about one-third of the program's budget went to actual cleanup work, this accelerated cleanup strategy is intended to reduce the time needed to complete the cleanup of sites.[16] DOE says that by implementing cleanup actions more quickly, it can reduce the amount it spends on maintenance, fixed costs, and other activities required to support safety and security. At the Oak Ridge plant, DOE plans to accelerate the plant's cleanup and closure time frame from 2016 to 2008. DOE estimates that this acceleration in cleanup and closure could achieve cost savings of $465 million.[17] DOE has also proposed an accelerated cleanup plan for the Paducah plant. This plan, submitted to state and federal regulatory authorities for approval in November 2003 and approved in April 2004, establishes (1) a series of prioritized response actions, (2) ongoing site characterizations to support future response action decisions, and (3) decontamination and decommissioning of the currently operating gaseous diffusion plant once it ceases operations.[18] DOE's plan reduces the time frame for completing the prioritized response actions from 2030 to 2019 and could, according to DOE estimates, save about $288 million. DOE is continuing negotiations with state and federal regulatory authorities in hopes of further reducing the time frame for completion of the prioritized response actions. However, as we reported in April 2004, the total scope of the cleanup at Paducah is unclear. Furthermore, DOE has not yet determined when D&D of the plant facilities currently in use will begin.

DOE is also revisiting each plant's envisioned end state to determine if cleanup at each plant is based on a technical risk assessment appropriate for the sites' future land use. The 2002 environmental management review found that the current cleanup approach and, in some cases, interpretations of DOE's policy orders and requirements, as well as laws,

[16]Department of Energy, *A Review of the Environmental Management Program* (Washington, D.C., Feb. 4, 2002).

[17]DOE estimates that accelerating the cleanup at the Oak Ridge plant will reduce the overall cleanup cost by $866,176,000. However, this amount includes other activities not covered by the Fund. The savings to the Fund is an estimated $465,072,000.

[18]As we reported in our April 2004 report, DOE has had and continues to have difficulty in reaching stakeholder agreement on its cleanup plans. U.S. General Accounting Office, *Nuclear Waste Cleanup: DOE Has Made Some Progress in Cleaning Up the Paducah Site, but Challenges Remain*, GAO-04-457 (Washington, D.C.: April 2004).

regulations, and cleanup agreements, were too conservative and created obstacles to achieving the timely cleanup of the plants. As a result, DOE required each of its environmental management sites, including the three plants, to develop a risk-based "vision" to identify acceptable risk levels consistent with the site's future land use, including an analysis that identified the differences between the current end state and one that is based on a risk assessment. Each of the uranium enrichment plants has developed a draft risk-based end state vision that is currently under review by DOE headquarters, state and federal regulatory officials, and local stakeholders. Once these visions are approved, the plants will re-evaluate their strategic approaches and cleanup activities to determine if renegotiating cleanup agreements is appropriate. According to DOE officials, if it is determined that changes are necessary, any changes would be made in accordance with all applicable requirements and procedures, including public involvement and regulatory approval. However, state and federal regulators with whom we spoke are concerned that if the plants are required to renegotiate cleanup agreements as a result of proposed changes, the cleanup process could be delayed, in turn resulting in increased costs. For instance, federal and state regulatory officials at Oak Ridge are concerned that, given the amount of work remaining and the short time frame for the plant's closure, DOE might be unable to meet its projected 2008 closure date if respective parties have to renegotiate already agreed-upon cleanup standards.

Based on Current Projected Costs and Revenues, the Fund Will Not Be Sufficient to Complete Cleanup at the Three Plants

Despite DOE efforts to reduce costs, we found that based on current projected costs and revenues, the Fund will be insufficient to cover authorized activities. We determined that the Fund will be sufficient to cover the reimbursements to the uranium and thorium licensees. However, our Baseline model demonstrated that by 2044, the most likely time frame for completion of cleanup at the three plants, cleanup costs will have exceeded revenues by $3.5 billion to $5.7 billion (in 2004 dollars). Importantly, we found that the Fund would be insufficient irrespective of which estimates we used, including models that estimated the final cleanup work at the plants under (1) accelerated time frames, (2) deferred time frames, or (3) baseline time frames, and with additional contributions to the Fund equaling the difference between the amounts that have been appropriated to date and the total amount authorized under the Energy Policy Act. Given the numerous uncertainties surrounding the cleanup work at the nation's three uranium enrichment plants, it is not possible to more precisely determine the total resources needed to cover the Fund's authorized activities until DOE has better information about such factors

as the dates for beginning and completing the decommissioning work at the Paducah and Portsmouth plants.

Our Baseline model demonstrated that by the time all cleanup at the plants is completed, costs will have exceeded revenues by $3.5 billion to $5.7 billion (in 2004 dollars). The Baseline model was developed using cost estimates that assumed cleanup, including the decontamination and decommissioning of all facilities (final D&D), would occur by 2044. This time frame was developed in consultation with DOE officials about what the most likely cleanup time frames would be. It is important to note, however, that DOE has not yet made a decision about when the final D&D will occur at the Paducah and Portsmouth plants.

Because DOE has not determined when final D&D will begin at the Paducah and Portsmouth plants, we also developed two alternative models—Accelerated and Deferred—to assess whether the timing of the final D&D work at these plants would have a significant impact on the total costs. Total cleanup time was reduced by 20 years in the Accelerated model and increased by 8 years in the Deferred model. The timing of D&D can affect total cleanup costs because, among other things, each plant must pay significant annual security and maintenance costs that will be incurred as long as DOE maintains facilities on the sites. For example, at the Paducah plant, the safeguarding and security costs after the plant is shut down are projected to be more than $26 million annually (in 2004 dollars).

We found that irrespective of what model we used—Accelerated or Deferred—the Fund will be insufficient to cover the projected cleanup costs at the uranium enrichment plants. In present value, the Fund deficiency would range from a high of $3.8 billion in the Accelerated model to a low of $0.63 billion in the Deferred model.[19] Thus, while accelerating or deferring the cleanup at the Paducah and Portsmouth plants could affect overall costs, the Fund would still be insufficient to cover the total cleanup

[19]Because of the difference in completion dates, the comparison of the Fund balance in constant 2004 dollars would not be meaningful. To make the comparison of the various models possible, we estimated the present value of the Fund's balance in 2004 dollars. Because present value analysis reflects time value of money—that costs are worth more if they are incurred sooner and worth less if they occur in the future, the present value under the deferral model declines more than the other options. However, in reality the net effect would depend on many other factors. If, for example, deferral of D&D would add substantially to such costs as safeguarding and security or costs associated with increased health risks then the reduction due to adjusting for time value of money could be more than offset by increases in other costs.

costs irrespective of the time frames of final D&D at the Paducah and Portsmouth plants.

Because federal contributions to the Fund have been less than the authorized amount, we also developed two models to assess the affect of additional contributions from government appropriations.[20] First, we developed a model—Revenue Added—that continued government contributions to the Fund until they equaled the total amount authorized under the Energy Policy Act. Building on this model, we developed an additional Revenue Added Plus Interest model that calculated and added to the Fund the interest that would have been earned if all authorized government contributions had been made. We found that under both models, despite additional revenues, the Fund would still be insufficient to cover all cleanup costs. In present value, the Fund deficiency would range from a high of $2.6 billion in the Revenue Added model to a low of $0.09 billion in the Revenue Added Plus Interest model. Even if the full amount of funds authorized by law were appropriated, and interest accrued on this additional amount, cleanup costs would still exceed revenues.

While our analysis was able to capture several uncertainties surrounding the Fund—including interest rates, inflation rates, cost and revenue variances, and the timing of final D&D—there are additional uncertainties we were unable to capture, including uncertainties due to possible changes in the scope of the cleanup; whether the Fund will be required to pay for additional activities, such as long-term groundwater monitoring once the plants are closed; as well as potential litigation costs the Fund would have to support. Significant changes in the scope of the cleanup work could impact the costs of cleanup activities at the plants. For example, a recent risk analysis exercise completed by DOE for the Paducah plant indicated that such changes could increase cleanup costs by more than $3 billion and extend the time frame for cleanup to more than 30 years past the original scheduled end date of 2019.[21] Additionally, uncertainties surrounding waste disposal at the Paducah and Portsmouth plants could significantly impact cleanup costs. Current DOE cost estimates assume that on-site disposal facilities will be built, which would minimize waste transportation costs.

[20]According to DOE's records, at the start of fiscal year 2004, the government's actual contributions to the Fund were $707 million less than the amount authorized under the Energy Policy Act.

[21]This end date does not include final D&D of the plant, but only includes the major remedial actions currently planned at the site.

These facilities have yet to be constructed at the plants or agreed upon by regulatory authorities. However, if DOE is not able to build these on-site facilities, waste disposal costs could increase substantially. For example, at the Portsmouth plant, contractor officials estimated that if they have to ship all of the waste off site, disposal would cost at least $515 million (in 2002 dollars) more than the projected cost of disposing of the waste in an on-site facility.

Further, there may be additional activities the Fund is required to support that are not currently included in DOE's cost projections. For example, after each site has completed all of the necessary cleanup work, there will be long-term stewardship costs at the plants, such as continual groundwater monitoring. Currently, DOE officials assume these long-term stewardship costs will be covered by a separate funding source. Similarly, the costs to store and dispose of each plant's depleted uranium hexafluoride are currently covered by a separate appropriation. However, DOE officials acknowledge that if another funding source is not available for these costs, they may be required to use resources from the Fund.

Finally, litigation costs supported by the Fund are another source of uncertainty. Future litigation costs could vary depending on the extent to which lawsuits are pursued and whether the actions are decided in favor of the federal government. Various legal claims related to domestic utility company assessments have been made against the Fund. All of the actions decided to date have been in favor of the federal government. However, additional claims may be filed. Additionally, there have been litigation costs associated with lawsuits against DOE by workers and adjoining landowners at the Paducah and Portsmouth plants, often concerning allegations of property or human health damages.

Conclusions

Based on DOE's current estimates, and the most likely time frame for completing cleanup, costs will exceed revenues in the Fund by $3.5 billion to $5.7 billion (in 2004 dollars). However, DOE has yet to make a number of decisions that will impact the costs of cleanup, including when decontamination and decommissioning at the Paducah and Portsmouth plants will occur. Until DOE resolves some of these uncertainties and has more specific information, it is impossible to more precisely determine the total funds necessary to cover the authorized cleanup activities. While the precise amount of additional revenue needed cannot be determined, our analysis shows that additional contributions to the Fund beyond its current 2007 expiration date will be necessary to cover the costs of authorized

activities irrespective of when DOE decides to undertake D&D of the Paducah and Portsmouth plants. Because the Paducah and Portsmouth plants are now estimated to cease operations by 2010 and 2006, respectively, DOE should be able to develop plans, including more precise cost estimates, for D&D of these plants. Extending the Fund by an additional 3 years would give DOE an opportunity to develop these plans and a better estimate of the costs to clean up the plants. With this information, DOE could better determine if further extensions to the Fund will be necessary.

Matters for Congressional Consideration

In order to better ensure that the Fund will be sufficient to cover the projected costs for authorized activities, the Congress should consider

- reauthorizing the Fund for an additional three years to 2010, and
- requiring DOE to reassess the sufficiency of the Fund before the expiration date to determine if extensions beyond 2010 will be necessary.

Recommendations for Executive Action

To help reduce uncertainty regarding the sufficiency of the Fund, we are recommending that the Secretary of Energy take the following two actions:

- develop a decontamination and decommissioning plan for the Paducah plant that would identify the most probable time frames and costs for completing final D&D, and
- develop a decontamination and decommissioning plan for the Portsmouth plant that would identify the most probable time frames and costs for completing final D&D.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for review and comment. DOE generally agreed that our report accurately presents the current status of the Fund and concurred with the report's matters for congressional consideration. DOE also stated that it would develop decontamination and decommissioning plans for the remainder of the facilities at Paducah and Portsmouth "at the appropriate time," but did not indicate when would be an "appropriate time." We recognize that the decontamination and

decommissioning of the Paducah and Portsmouth plants may not occur for years and that any plans developed by DOE would have to be periodically updated. However, many of the uncertainties that currently exist and could have significant impact on the costs of DOE efforts will not be resolved until DOE develops D&D plans for the Paducah and Portsmouth plants that identify the most probable time frames and costs for completing final D&D. We recommended that the Congress consider extending the Fund for 3 years, in part, to provide DOE with an opportunity to develop these plans. Until DOE does so, it will not be able to develop a more precise estimate of the total funds necessary to cover the authorized cleanup activities or to reassess the sufficiency of the Fund and determine if further extensions are necessary.

DOE also provided technical comments that we incorporated, as appropriate. DOE's written comments on our report are included in appendix III.

Scope and Methodology

To determine what actions DOE has taken to reduce the cleanup costs the Fund is authorized to support, we reviewed the National Academy of Sciences' 1996 report that identified 13 major cost reduction recommendations for the nation's three uranium enrichment plants.[22] We met with Academy officials to gain further information about the study and with DOE and its contractor officials at each of the plants to determine the extent to which DOE has taken actions to address the recommendations. While we were able to obtain information on actions taken to date, DOE could not determine whether the actions were taken as a result of the Academy's recommendations. DOE was also generally unable to provide information regarding the cost savings, if any, achieved by implementing these actions. To determine other steps DOE has taken to reduce cleanup costs, we visited all three plants and interviewed DOE and contractor officials from DOE headquarters, the Oak Ridge Operations Office, the Lexington Office, and the site offices at each of the three plants. Additionally, we obtained and analyzed documentation regarding DOE's accelerated cleanup strategy at the Oak Ridge and Paducah plants, including the plants' planning documents and other DOE management reports. We also obtained and reviewed each of the three plants' draft risk-

[22]National Academy of Sciences, *Affordable Cleanup? Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities* (Washington, D.C., 1996).

based end state vision documents, to understand DOE's proposed options for consideration. Additionally, we attended a public meeting in Paducah, where DOE presented a draft risk-based end state vision to the community, to better understand the proposal. We also interviewed regulatory authorities responsible for overseeing cleanup activities at the plants, including officials at the Environmental Protection Agency's Region IV and Region V, the Commonwealth of Kentucky's Department for Environmental Protection, the Tennessee Department of Environment and Conservation, and the Ohio Environmental Protection Agency.

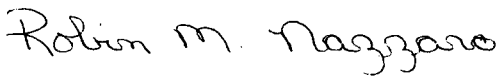
To assess the sufficiency of the Fund to pay for the total projected costs of the Fund's authorized activities, we interviewed DOE and contractor officials responsible for the Fund's financial data and obtained DOE's current estimates for uranium and thorium reimbursement costs, the cleanup costs at the three plants, and the current and likely revenue projections. We used these data to develop a number of simulation models that factored in the cost and revenue projections on an annual basis and uncertainties surrounding inflation rates, interest rates, costs, revenues, and the timing of the final D&D work at the Paducah and Portsmouth plants. See appendix I for a detailed description of our modeling methodology, assumptions, and results. We interviewed DOE and contractor officials from DOE Headquarters, the Oak Ridge Operations Office, the Lexington Office, and the site offices at each of the three plants, as well as officials from the federal and state regulatory offices party to the plants' cleanup agreements. We also toured the Oak Ridge plant to identify the major uncertainties that could impact future cleanup costs at the plants.

In addition, we assessed the reliability of the data used to develop our simulation models. We obtained, from key DOE and contractor database officials, responses to a series of data reliability questions covering issues such as data entry access, quality control procedures, and the accuracy and completeness of the data. Follow-up questions were added whenever necessary. We also interviewed DOE and contractor officials and reviewed relevant documentation to determine how cost estimates for future cleanup, including the final D&D work, were developed at each of the plants. We obtained historical cost estimates for several D&D projects completed at the Oak Ridge plant and compared them with updated or actual costs. We also interviewed and obtained relevant work papers from KPMG, a private accounting firm hired by the DOE Inspector General's Office to conduct annual financial audits of the Fund, to understand and incorporate their audit findings. KPMG's annual financial audits have

concluded that the cost and revenue data related to the Fund appear to be complete and accurate, that internal controls are operating effectively, and that Fund managers have complied with all significant provisions of laws, regulations, and compliance agreements. Based on our own work, in conjunction with that of KPMG, we determined that the financial data provided were sufficiently reliable for the purposes of our report.

We are sending copies of this report to the Secretary of Energy. We will also make copies available to others upon 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 on this report, please call me at (202) 512-3841. Other staff contributing to this report are listed in appendix IV.



Robin M. Nazzaro
Director, Natural Resources and Environment

List of Congressional Committees

The Honorable Pete V. Domenici
Chairman
The Honorable Jeff Bingaman
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

The Honorable Joe Barton
Chairman
The Honorable John D. Dingell
Ranking Minority Member
Committee on Energy and Commerce
House of Representatives

Fund Modeling Methodology, Assumptions, and Results

This appendix describes the methodology, assumptions, and results of the models we developed to evaluate the sufficiency of the Uranium Enrichment Decontamination and Decommissioning Fund (Fund). Specifically, this appendix contains information on the following:

- the simulation technique and the Baseline model we developed to estimate the balance of the Fund by the time all cleanup activities are scheduled to be completed;
- the data sources, assumptions, and uncertainties we used for the Baseline model;
- the additional models—Accelerated, Deferred, Revenue Added, and Revenue Added Plus Interest—that we developed to analyze the effects of additional uncertainties associated with decontamination and decommissioning time frames and revenues to the Fund;
- our simulation results for individual models as well as a comparison of results from the alternative models.

Modeling Methodology

To conduct our analysis, we first developed an Excel spreadsheet simulation model that annually tracked all estimated contributions to and payments from the Fund starting in fiscal year 2004 and extending out until all cleanup activities are scheduled to be completed. We also estimated the interest that could be earned by unused balances of the Fund each year, and included these earnings in the annual Fund balance.[1] Our analysis began with the Fund balance at the end of fiscal year 2003 and continued until all cleanup work at the three uranium enrichment plants was projected to be completed. The completion date for the Baseline model and Revenue models was set at fiscal year 2044—the most likely date for the completion of all cleanup activities at the three plants. However, for the Accelerated and Deferred models, the completion dates were set at fiscal year 2024 and fiscal year 2052, respectively.

Building on the Excel spreadsheet model, we used a commercially available forecasting and risk analysis software program called Crystal Ball to model the uncertainties associated with cost and economic assumptions

[1]The Energy Policy Act provided that balances in the Fund be invested in Treasury securities and any interest earned be made available to pay for activities covered under the Fund.

used in the model. Using the Crystal Ball program in concert with the Excel model, we were able to expand our capability to explore a wide range of possible values, instead of one single value, for such variables as interest rates, inflation rates, and cleanup costs. The Crystal Ball program uses a process called Monte Carlo simulation. That is, it repeatedly and randomly selects values for interest rates, inflation rates, and costs from distribution ranges that we prespecified for these variables. Using these values for the appropriate cells in the spreadsheet model, Crystal Ball then makes the calculations and forecasts the results. Repeating the same process, Crystal Ball can calculate the results based on hundreds or thousands of such trials. Our simulation results were based on 1,500 different trials. The Crystal Ball program produces the entire range of forecasts for the given model and shows the confidence level for, or the likelihood associated with, any specific forecast.

Baseline Model Data, Assumptions, and Uncertainties

The Department of Energy (DOE) and its contractor was our primary source for all the cost data used to develop our Baseline model. For Fund revenues, we generally assumed the Fund would receive contributions as authorized by current legislation. DOE also provided us with the time frames for completing the cleanup work at each of the plants and, when possible, contingency estimates for the costs. Since DOE's cost data were provided in different dollar values, we converted all cost data to 2004 dollars using either the inflation rates used by DOE or the Consumer Price Index. More specific sources of data and assumptions to the modeling work were as follows:

Revenues to the Fund. To construct the Baseline model, we assumed contributions to the Fund would come from three sources: federal government appropriations, payments from domestic utility companies, and interest earned on investments of Fund balances. We assumed that government contributions would continue from fiscal years 2004 through 2007, as authorized by the Energy Policy Act. However, for the federal government contributions in fiscal years 2004 and 2005, we used actual appropriations and the President's budget request, respectively; for the remaining years, we assumed contributions would be at the level authorized in the current legislation. For payments from domestic utility companies, we assumed the assessment would remain unchanged at the fiscal year 2004 level, and assumed payments would continue through fiscal year 2007, as authorized by the Energy Policy Act. Additionally, as required by law, the Fund can accrue interest income from investing the unused balance of the fund in government securities. Therefore, we

estimated the investment earnings of the Fund annually and included it in the available Fund balances. To calculate investment earnings, we used a range of different interest rates based on the Fund's previous earnings. We assumed that the real interest rate earned on the Fund investment has a triangular distribution, with minimum and maximum values based on historical performance of the Fund's investments since 1994. Similarly, we used the performance of the Consumer Price Index since 1994 to develop a triangular distribution for price indices to adjust the data where necessary.

Costs of the Fund. DOE, in conjunction with its contractor officials responsible for conducting the cleanup work at the three uranium enrichment plants, provided cost estimates for all anticipated activities that will be paid for from the Fund starting in fiscal year 2004, and that will carry forward until all cleanup activities have been completed at each of the three plants. Cost estimates included (1) reimbursements to uranium and thorium licensees and (2) costs to complete the cleanup at the three uranium enrichment plants.

1. *Reimbursements to uranium and thorium licensees*. The Energy Policy Act authorized reimbursements to uranium licensees not to exceed $350 million and reimbursements to the thorium licensee not to exceed $365 million for the portion of their cleanup costs associated with the sale of these materials to the federal government. The remaining unused authorized amounts are adjusted annually based upon the Consumer Price Index. We assumed that the annual reimbursement amount will be fixed at the fiscal year 2004 level and will carry forward until the total amount authorized by law has been allocated. Based on the current balance of the Fund, anticipated revenues, and the total available reimbursement amount remaining, we determined that the Fund would be sufficient to cover the reimbursements to the uranium and thorium licensees.[2]

2. *Cleanup costs at the three uranium enrichment plants*. Cleanup costs for decontamination and decommissioning (D&D) work were kept separate from all other cleanup cost activities, which include remedial actions, waste management, surveillance and maintenance, and other (including all other activities the Fund supports such as litigation fees

[2]At the end of fiscal year 2003, the Fund balance was $3.4 billion, whereas the total remaining balance for reimbursements was about $400 million—a total of $214 million had been paid to uranium licensees and $171 million had been paid to the thorium licensee.

and funds to support site-specific advisory boards). Cleanup costs were broken out annually and by each plant. Due to the different uncertainties surrounding these costs, D&D costs were then further segregated for process buildings (the large buildings where uranium is enriched) and all other remaining D&D costs. The Baseline model costs for the cleanup activities at the three plants were developed under the assumption that the final D&D (all D&D and other required cleanup actions at the plants once the facilities cease operations) would occur between 2004 and 2008 at the Oak Ridge plant; between 2018 and 2032 at the Paducah plant; and between 2010 and 2044 at the Portsmouth plant. These are the most likely time frames for completing the final D&D work, based on discussions with DOE and contractor officials.

Cost Uncertainties. To capture uncertainties inherent in the data, we used the Crystal Ball program in concert with the Baseline model we developed. With the Crystal Ball program, we could assign a range of values, rather than a single value, to each cell of the spreadsheet model. We developed the range of values for each cost category based on extensive discussions with DOE and its contractor staff who provided the cost estimates. After considering their recommendations and input, we assumed that all cleanup costs at the three uranium enrichment plants, with the exception of D&D of the process buildings at the Paducah and Portsmouth plants, could increase by a uniform probability of up to 20 percent.[3] Given the considerable uncertainty associated with costs for D&D of the process buildings and the experience to date at the Oak Ridge plant, we assumed, based on the values provided by DOE, the costs for this work at Paducah and Portsmouth could increase by a uniform probability of up to 85 percent.[4]

Alternative Models

Because not all uncertainties could be incorporated into one model, we developed several alternative models to our Baseline model. Specifically,

[3]Uniform probability of up to 20 percent indicates costs could increase by any factor between 0 and 20 percent, with all values having equal likelihood of occurring.

[4]We found that the cost to D&D the major process buildings at the Oak Ridge plant is now estimated to be about 85 percent higher than the cost estimate that was developed in 2000. The Paducah and Portsmouth plants' process buildings cost estimates were also developed in 2000, and were largely based on the same assumptions used to develop the Oak Ridge cost estimate. In general, officials with whom we spoke agreed that based on the experience at Oak Ridge, costs could increase in a similar fashion at Paducah and Portsmouth.

since DOE has not determined when final decontamination and decommissioning of the Paducah and Portsmouth plants will begin, we developed two alternative models—Accelerated and Deferred—to show the effects of different timing assumptions on the sufficiency of the Fund. Further, because federal contributions to the Fund have been less than the authorized amount, we developed two additional models—Revenue Added and Revenue Added Plus Interest—to include additional contributions to the Fund based on revenues from federal government appropriations. These alternative models were built using the same data, assumptions, and uncertainties that were used for the Baseline model, except for specific changes discussed below.

Accelerated and Deferred Models

Because DOE has not determined when the final decommissioning and decontamination work for the Paducah and Portsmouth uranium plants will begin and when it will be completed, DOE, in conjunction with its contractor officials, developed two additional cost series for the Paducah and Portsmouth plants that varied in the start and completion dates for the final D&D work, which we then incorporated into our Accelerated and Deferred models. The completion of all D&D activities in the Accelerated model was reduced by 20 years from 2044 to 2024, and increased by 8 years in the Deferred model to 2052.

The Accelerated cost series was developed under the assumption that final D&D could be completed faster than under the Baseline model, given unconstrained funding. For the Accelerated approach, Paducah's final D&D work would begin in 2010 and end by 2024; Portsmouth's final D&D work would begin in 2007 and be completed by 2024. These time frames were determined in consultation with DOE and contractor officials. They represent the soonest the D&D work would most likely start, according to DOE and its contractor officials, and represent the earliest likely time frame that the total D&D and other associated cleanup work could be completed.

The Deferred cost series was developed under the assumption that given current funding constraints, it may not be realistic for two major D&D projects to be carried out concurrently. Thus, Deferred time frames were determined by DOE, assuming that all work would be completed at the Portsmouth plant first and then initiated at the Paducah plant. For the Deferred model, Portsmouth's final D&D work was estimated to be completed from 2010 to 2037 and Paducah's from 2038 to 2052.

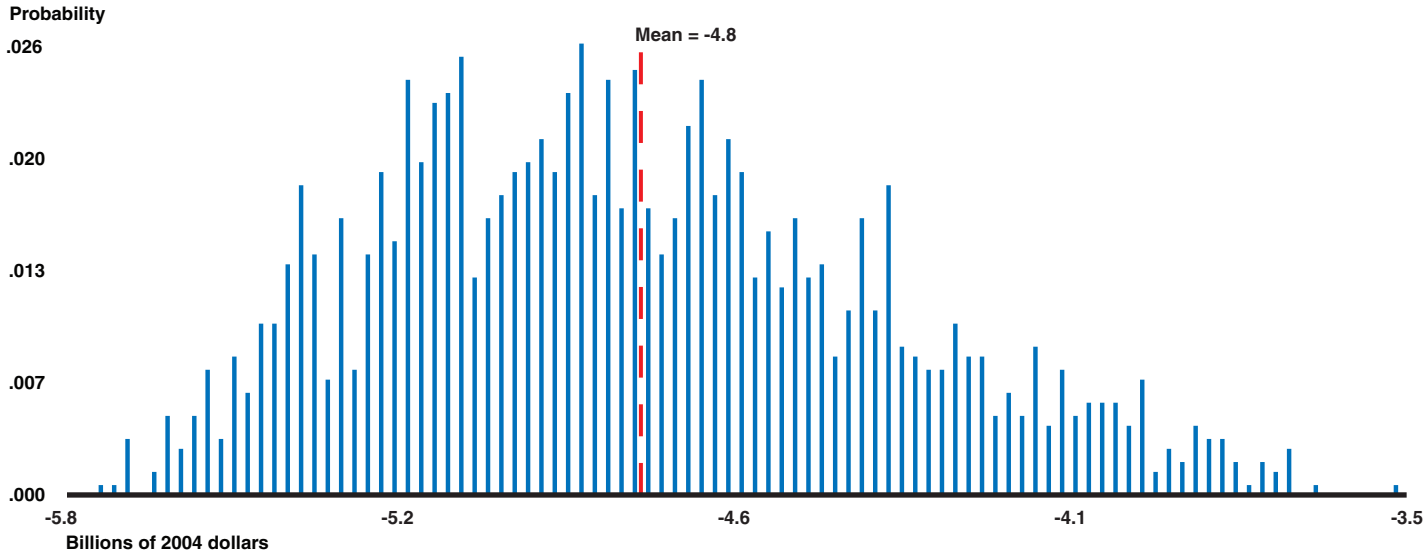
Revenue Added Models

According to DOE's records, by the start of fiscal year 2004, when our analysis begins, the government's actual contributions to the Fund were $707 million less than authorized under the Energy Policy Act. To capture the effect of the government meeting its total authorized annual contributions on the balance of the Fund, we developed two additional models—a Revenue Added and a Revenue Added Plus Interest model. For the Revenue Added model, we assumed that government contributions to the Fund would continue annually at the authorized level until the total government contributions as authorized by law had been met, which would occur in fiscal year 2009. For the Revenue Added Plus Interest model, we built on the Revenue Added model to include the effect of forgone interest that the Fund could have earned if the government had contributed the full authorized amount. In other words, we continued government payments into the Fund until the total amount authorized (regardless of amounts actually appropriated), as well as interest on the unpaid portion of the authorized amount, is paid to the Fund. We assumed these additional payments would be made to the Fund in the same amounts as the 2004 annual authorized amount, which extended payments through fiscal year 2010.

Results

The balance of the Fund at the projected completion of all cleanup work indicated whether the Fund will be sufficient to cover all costs identified by DOE. We estimated the Fund balance in current (year of completion) dollars and constant 2004 dollars. However, to compare the results of various models with different completion dates, we also estimated the present value of the Fund's balance in 2004. For each model, the Crystal Ball program produced not only a range of possible values, but also the probability associated with that value, as well as the expected mean for the range. Figures 4 through 8 provide an overall illustration of the results produced by the models in constant 2004 dollars. In the figures, each bar shows the value by which costs could exceed revenues in billions of 2004 dollars. The height of each bar is the probability that the costs would exceed the revenues by that exact amount. Even though the probability of one specific amount is low, there is a 100 percent probability that the actual amount will fall somewhere within the range (e.g. for the Baseline model, minus $3.5 billion to minus $5.7 billion). As shown in figures 4 through 8, regardless of the model we used, the revenue going into the Fund will not be sufficient to cover all of the projected cleanup costs at the uranium enrichment plants.

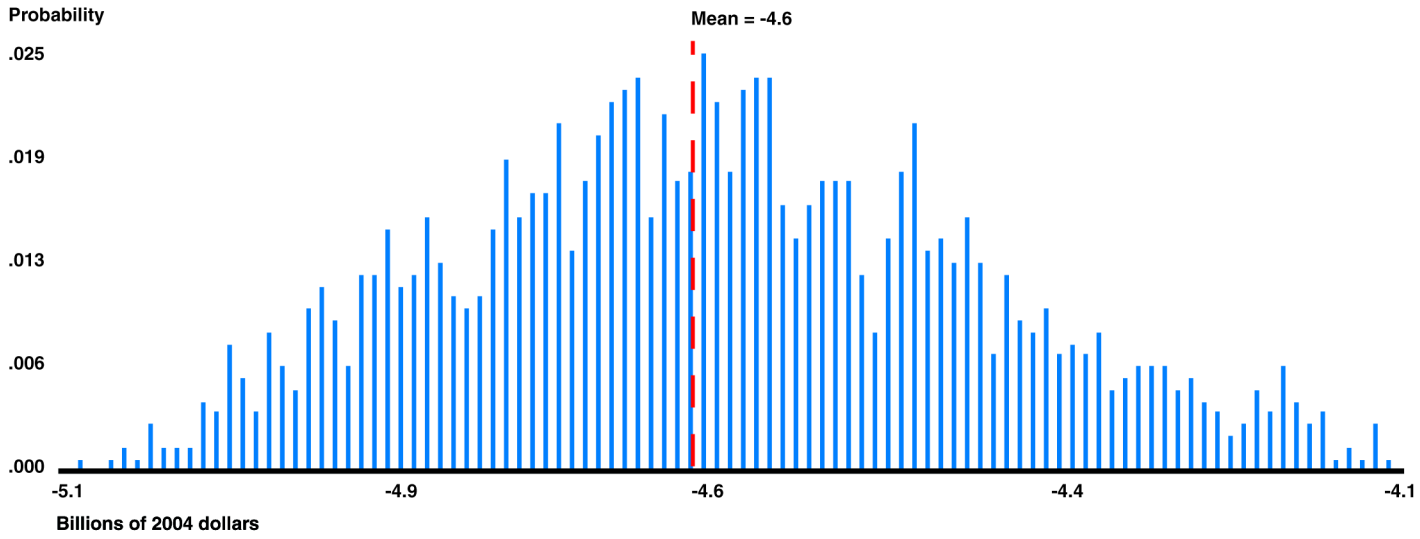
Figure 4: Baseline Model Results



Source: GAO analysis of DOE data.

Note: The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

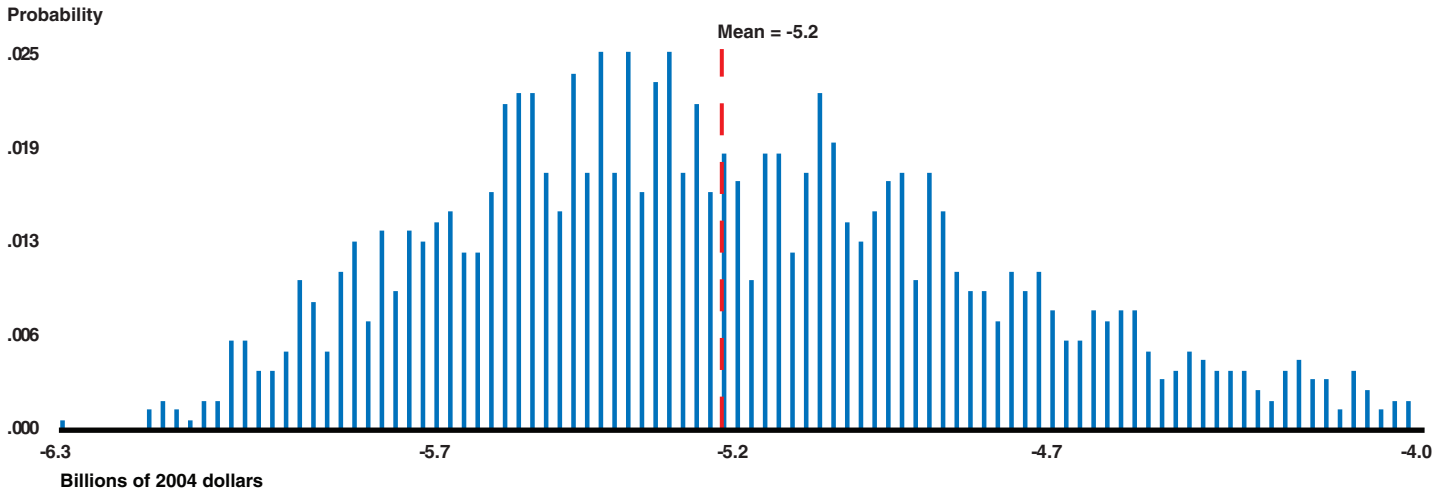
Figure 5: Accelerated Model Results



Source: GAO analysis of DOE data.

Note: The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

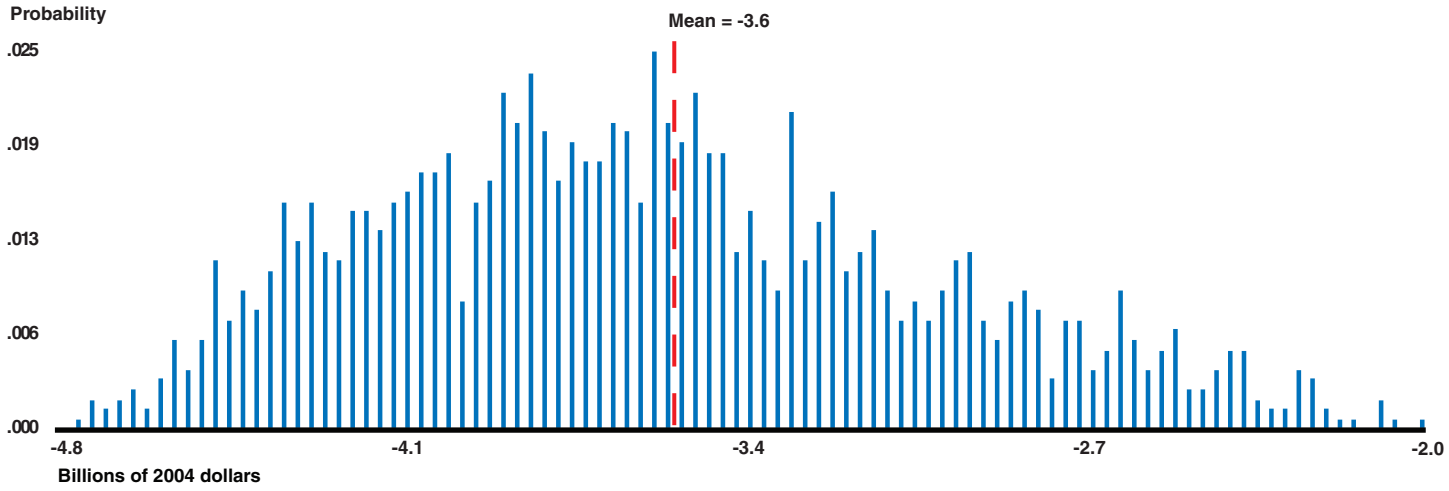
Figure 6: Deferred Model Results



Source: GAO analysis of DOE data.

Note: The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

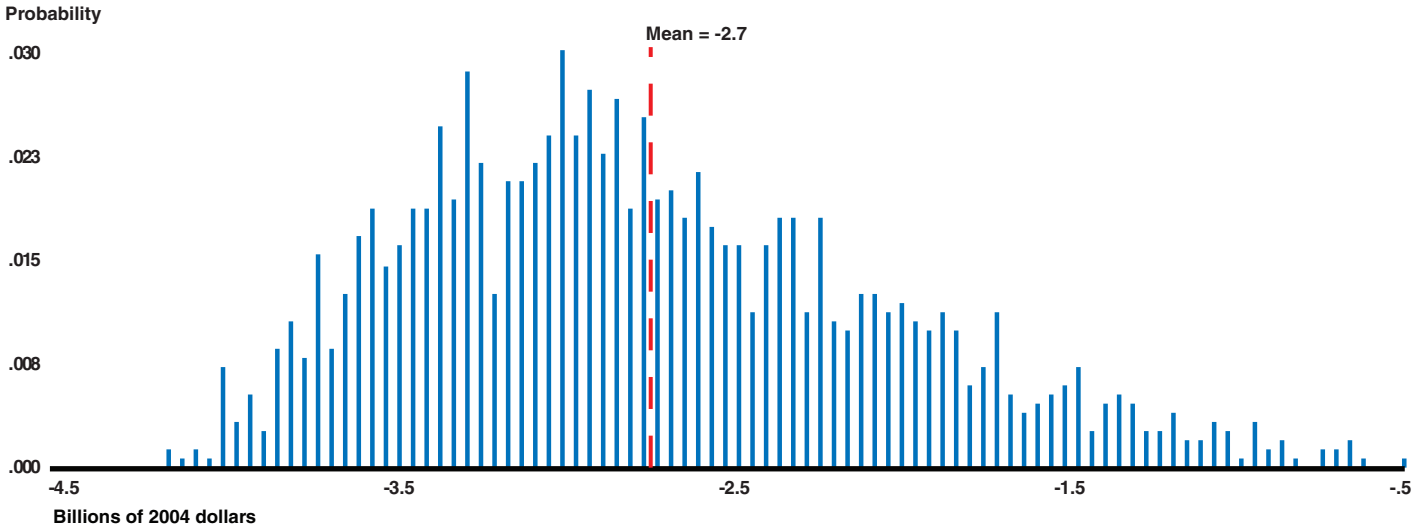
Figure 7: Revenue Added Model Results



Source: GAO analysis of DOE data.

Note: The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

Figure 8: Revenue Added Plus Interest Model Results

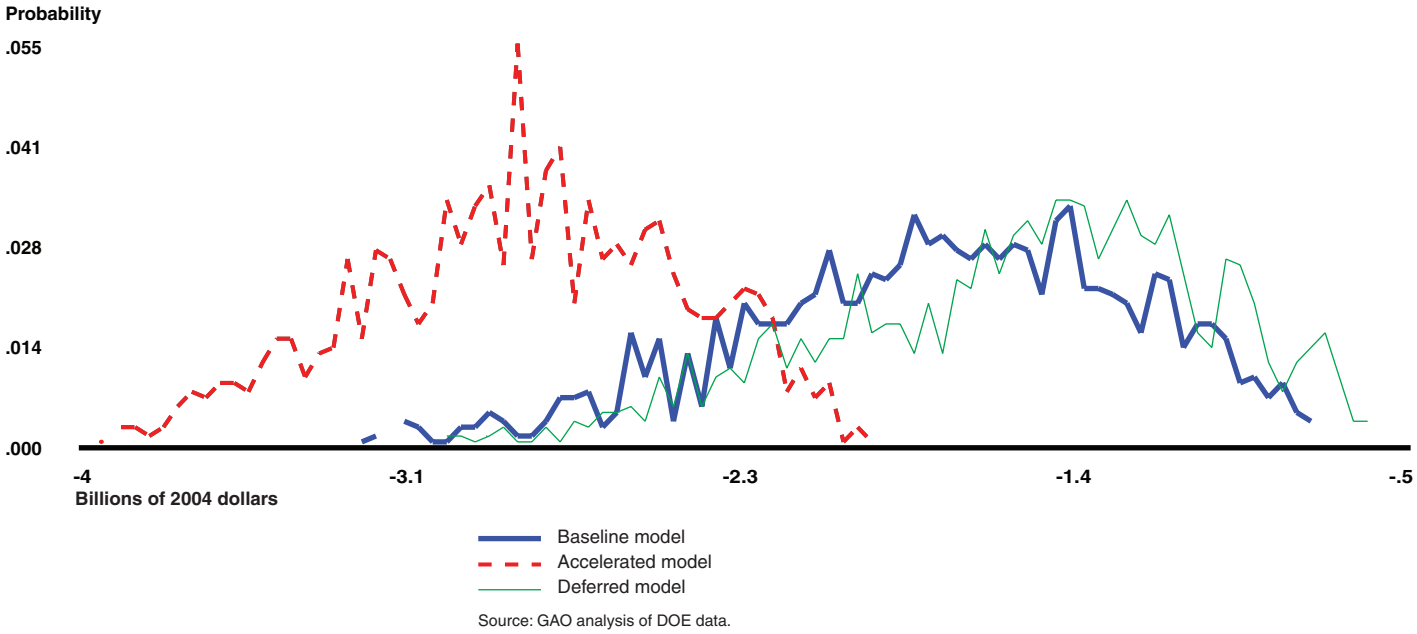


Source: GAO analysis of DOE data.

Note: The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

The figures show the results for the individual models in constant 2004 dollars in the year DOE projected that all cleanup work will be completed. Because of the difference in the completion dates, the comparison of the Fund balances across the different models will not be meaningful. To make the comparison of the balances possible, we also estimated the present value of the Fund in 2004 dollars. Figure 9 shows in present value how the Fund balance of the Baseline model compares with the Accelerated and Deferred models; Figure 10 shows in present value how the Fund balance of the Baseline model compares with the two Revenue Added models.

Figure 9: Present Value of Fund Balance for Baseline, Accelerated, and Deferred Models

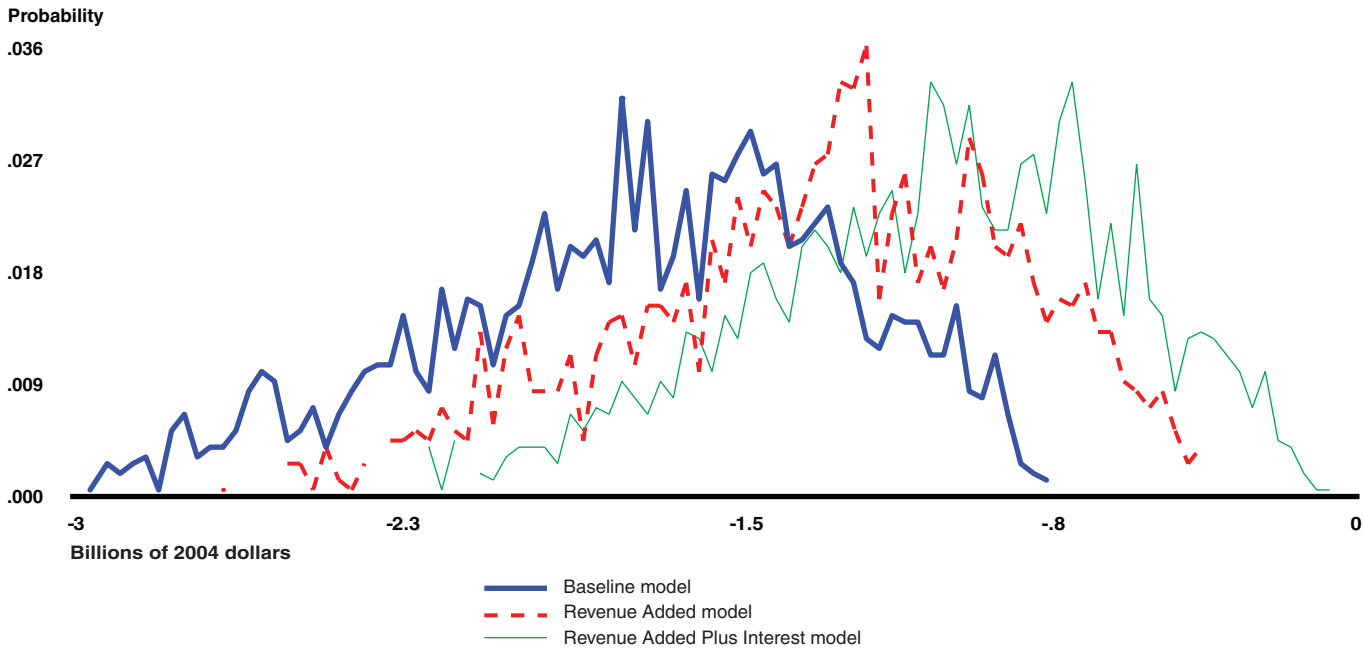


Source: GAO analysis of DOE data.

Notes: In order to compare the results of various models with different completion dates, we estimated the present value of the Fund's balance in 2004 dollars, as represented here.

The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

Figure 10: Present Value of Fund Balance for Baseline, Revenue Added, and Revenue Added Plus Interest Models



Source: GAO analysis of DOE data.

Notes: In order to compare the results of various models with different completion dates, we estimated the present value of the Fund's balance in 2004 dollars, as represented here.

The values on the horizontal axis of the figure are to provide a scale and do not correspond exactly to the ranges of the Fund balance, which are provided in table 2.

The specific values for which the Fund could be insufficient under the various models are shown in table 2. Though the Deferred model showed the greatest insufficiency in the year the cleanup work is projected to be completed, once the timing of expenditures is considered as in the present value analysis, the deficiency of the Deferred alternative was not significantly different from other models. On the other hand, the deficiency of the Fund, as measured in present value mean, was the lowest in the Revenue Added Plus Interest model. In this model, cleanup costs would exceed revenues by $0.09 billion to $2.3 billion.

Table 2: Comparison of Models

Dollars in billions

	Baseline model	Accelerated model	Deferred model	Revenue Added model	Revenue Added Plus Interest model
Completion date (fiscal year)	2044	2024	2052	2044	2044
Fund balance at completion of all cleanup: range (mean)					
Constant 2004 dollars	-$5.7 to -$3.5	-$5.2 to -$4.0	-$6.2 to -$4.0	-$4.7 to -$1.8	-$4.2 to -$.43
	(-$4.8)	(-$4.6)	(-$5.2)	(-$3.6)	(-$2.7)
Current dollars	-18.5 to -7.6	-9.8 to -5.7	-26.4 to -8.8	-15.1 to -4.3	-13.3 to -1.0
	(-12.5)	(-7.6)	(-16.7)	(-9.3)	(-7.1)
Present value 2004 dollars[a]	-3.1 to -.77	-3.8 to -1.8	-3.1 to -.63	-2.6 to -.39	-2.3 to -.09
	(-1.7)	(-2.7)	(-1.5)	(-1.3)	(-1.0)

Source: GAO analysis of DOE data.

[a]Because of the difference in completion dates, the comparison of the Fund balance in constant 2004 dollars would not be meaningful. To make the comparison of the various models possible, we estimated the present value of the Fund's balance in 2004 dollars. Because present value analysis reflects time value of money—that costs are worth more if they are incurred sooner and worth less if they occur in the future, the present value under the deferral model declines more than the other options. However, in reality the net effect would depend on many other factors. If, for example, deferral would add substantially to such costs as safeguarding and security or costs associated with increased health risks then the reduction due to adjusting for time value of money could be more than offset by increases in other costs.

DOE Actions Taken That Addressed the National Academy of Sciences' Cost Reduction Recommendations

This appendix describes the actions taken by DOE that address the National Academy of Sciences' (Academy) cost reduction recommendations. The Energy Policy Act directed the Academy to conduct a study and to provide recommendations for reducing the decontamination and decommissioning costs at the three uranium enrichment plants. In 1996, after convening a committee of academic and technical experts to carry out the study, the Academy released a report highlighting 13 major recommendations entitled *Affordable Cleanup? Opportunities for Cost Reduction in the Decontamination and Decommissioning of the Nation's Uranium Enrichment Facilities*. The recommendations address a variety of cost reduction approaches, including developing specific technologies and suggestions for planning, management, and regulatory coordination. While we were able to obtain information on actions DOE has taken that are consistent with the recommendations, DOE could not determine whether any actions to date were taken directly in response to the Academy's recommendations. Table 3 shows each of the Academy's major recommendations, the status of the recommendation, and an explanation of the actions taken by DOE that addressed the recommendation.

Table 3: Recommendations, Status, and Explanation of the Actions Taken by DOE

Recommendation	Status	Action taken
Focus of recommendation: management		
Rather than constructing a new administration building, existing facilities should be used to house the management and professional D&D staff.	Addressed	At the Oak Ridge plant, all DOE and contractor staff are housed in existing facilities. At the Paducah and Portsmouth plants, DOE plans to use existing structures to house staff when D&D efforts begin.
DOE should develop three plans—namely, headquarters level, plant-complex level, and site level—that address and integrate D&D of the facilities, environmental remediation activities, and the management of the depleted uranium hexafluoride.	Partially addressed	DOE has not developed a headquarters-level D&D plan that addresses and integrates D&D of all three plants with other DOE activities. While DOE's strategic plan discusses overall environmental management strategies and objectives, the plan does not specifically address D&D of the three plants as described by the Academy's recommendation. DOE also has not developed a complex-level D&D plan for the three plants. Oak Ridge is the only plant with an agreed-upon D&D plan that incorporates D&D, other cleanup activities, and the management of depleted uranium hexafluoride (a byproduct of the uranium enrichment process). The Paducah plant currently has a plan that lays out DOE's approach for a portion of its cleanup, but the plan does not include details for final D&D. DOE does not have a D&D plan for the Portsmouth plant. However, the DOE site manager said the agency is currently working to develop a Portsmouth strategic plan that will address final D&D, other cleanup activities, and management of depleted uranium hexafluoride.
An independent contractor should be selected through open competition and should be assigned total responsibility and accountability for all aspects of the assigned D&D work.	Partially addressed	In 1997, DOE awarded a contract to Bechtel Jacobs for cleanup work at the Oak Ridge, Paducah, and Portsmouth plants. Bechtel Jacobs was responsible for the planning and execution of remedial action, D&D, and waste management at the three plants (with the exception of three of the Oak Ridge plant's process buildings). In September 2003, DOE awarded a new contract to Bechtel Jacobs for completing the cleanup work at the Oak Ridge plant. Although the contract awarded in 1997 included all aspects of the cleanup at the Paducah and Portsmouth plants, DOE is currently in the process of bidding for two separate contracts at each plant—one for remedial actions and one for infrastructure and site maintenance—because of new federal contract initiatives.

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Recommendation	Status	Action taken
A prioritized cost- and risk-reduction approach should be used as the basis for developing the D&D plan. This approach should be used to accomplish D&D activities prior to the completion of the entire plan.	Partially addressed	In the 1990s, DOE developed a risk-based prioritization system to rank projects on the basis of overall risk reduction. DOE has now transitioned to a prioritization approach that maximizes the use of available resources while addressing near-term concerns first. The current prioritization criteria used by DOE, in order of importance, consist of the following: (1) imminent human health or safety risks, (2) compliance with existing enforceable regulatory agreements, (3) actions required to mitigate risks under current land use, and (4) activities that are on the critical path for efficient completion of the Environmental Management Program. While DOE has used this approach in developing the Oak Ridge plant's D&D plan, D&D plans, including the approach DOE will take, have not yet been developed for the Paducah and Portsmouth plants.
To reduce costs without compromising information security for the gaseous diffusion technology, DOE should try to define physical security requirements that allow uncleared workers under adequate supervision to conduct D&D operations. In addition, DOE should conduct an in-depth evaluation of the safeguards and security requirements during D&D to determine how their impact on D&D costs could be reduced.	Partially addressed	DOE is evaluating steps to allow access, under adequate supervision, to workers conducting D&D at the Oak Ridge plant who do not have clearances. For example, DOE recently approved a new security plan for the large process buildings at Oak Ridge. According to DOE officials, by taking actions such as reducing the number of times security forces search employees and constructing a perimeter fence around the outskirts of buildings to eliminate the need for searches each time employees enter or exit a building, they will not need to increase the security staff. Without these changes, DOE would have had to significantly increase the security staff on-site to handle the increased D&D activity. Additionally, the Oak Ridge plant has a sitewide safeguards and security plan that outlines security requirements across the site during D&D. According to DOE, this plan is continually updated to reduce security requirements as projects are completed, in order to reduce costs. The Paducah and Portsmouth plants do not have D&D plans that specify the security requirements that will be necessary during D&D operations. However, the DOE site manager said that at the Portsmouth plant, officials are actively looking at ways to reduce their security requirements as a part of an effort to develop a strategic plan for D&D of the site.

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Recommendation	Status	Action taken
Focus of recommendation: development of D&D technologies		
The high-assay decontamination facility should be eliminated; the low-assay decontamination facility should be simplified to focus primarily on aqueous decontamination and should be housed in existing buildings.	Addressed	Development of high-assay and low-assay decontamination facilities (facilities to disassemble and decontaminate equipment contaminated with enriched uranium) is no longer part of DOE's plans for D&D. DOE abandoned the construction of these facilities after an evaluation revealed how costly the process would be and instead has opted to dispose of the material into on-site landfills, which do not require aqueous decontamination. At Oak Ridge, this process is already under way. DOE officials assume a similar approach will be taken at the Paducah and Portsmouth plants when D&D is initiated at these plants. If DOE plans change or it is unable to obtain approval for on-site disposal cells at these sites, DOE may need to re-evaluate its approach.
A few highly focused D&D demonstrations should be undertaken to verify the cost and effectiveness of specific technologies, including the following two: 1. Optimization of aqueous decontamination to remove radioactive surface contamination from materials and process equipment, with special attention to Tc-99; and 2. Support of current DOE robotics programs, with highly focused demonstrations to verify potential cost savings and safety benefits.	Addressed	DOE has hosted several demonstrations and workshops to assess the effectiveness of specific D&D technologies. For example, DOE's contractor recently held a workshop to evaluate dismantlement technologies for removing specific buildings at the Oak Ridge plant. 1. According to DOE officials, there is no longer a need to utilize aqueous decontamination technology. The current waste acceptance criteria allow DOE to dispose of the materials into an on-site disposal facility whole, without first decontaminating the material. 2. DOE has evaluated different types of robotics for use at the Oak Ridge plant and the agency is currently using a quasi-robotics program. For example, a worker can sit in the cab of a robotic device and extend a mechanical arm to cut or sheer piping, cables, or wire, precluding the need to manually cut the materials.
The technical and management approaches used successfully for D&D of the United Kingdom's Capenhurst gaseous diffusion plant and for recently completed D&D projects with U.S. power reactors should be carefully considered by DOE to reduce costs for D&D of the U.S. plants.	Partially addressed	According to DOE officials, DOE has considered the technical and management approaches used at both the Capenhurst plant and other U.S. D&D projects, such as at the Hanford, Washington, site, to learn from their experiences and reduce costs. Specifically, at the Oak Ridge plant, DOE selected contractors who participated in D&D activities at other sites. For example, DOE awarded a contract to D&D several large process buildings at the Oak Ridge plant to British Nuclear Fuels Limited, based, in part, on its experience at the Capenhurst plant. DOE has not yet initiated final D&D at the Paducah and Portsmouth plants. However, the site manager for both of these plants acknowledged that it will be important to identify lessons learned from DOE's experiences at Oak Ridge and adopt best practices once D&D begins at the plants.

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Recommendation	Status	Action taken
A modest research program should be established to develop methods to decontaminate diffusion barrier material effectively.	Not applicable	DOE is currently not pursuing methods to decontaminate diffusion barrier material (the material used to separate and enrich uranium during the enrichment process). According to DOE officials, it is not necessary to decontaminate this material at the Oak Ridge plant because the material is placed directly into an on-site disposal cell, eliminating the need for decontamination. DOE assumes a similar approach will be taken at the Paducah and Portsmouth plants.
Focus of recommendation: regulatory and stakeholder involvement		
A stakeholder involvement program should be pursued to obtain timely and substantive public participation and input to ensure that social values are reflected in policy decisions.	Addressed	DOE has generally sought stakeholder involvement at each of the plants. DOE established Site Specific Advisory Boards at the Oak Ridge and Paducah plants that are staffed by local stakeholders. The boards' charters include providing input on cleanup policies and strategies and reviewing work plans and activities. While the Portsmouth plant does not have a Site Specific Advisory Board, DOE is currently working with the community to establish a stakeholder group to address DOE's new risk-based end state policy. DOE officials told us that they also regularly hold public meetings to present cleanup project plans and progress reports to Oak Ridge, Paducah, and Portsmouth city government organizations. Additionally, DOE has established information centers open to the public in or near all three communities. The centers provide information on each of the plant's respective cleanup activities, in addition to general information about its activities at other sites. The Portsmouth information center is located within the secure perimeter of the site, however, making public access somewhat less convenient than at the other two centers.
DOE should seek coordination of all regulatory aspects of D&D with the appropriate state and federal agencies early in planning to provide consistency during D&D planning and execution.	Partially addressed	DOE coordinates all of its cleanup planning activities through specific agreements with relevant state and federal regulatory officials. While mechanisms are in place to coordinate the regulatory aspects of its work, early coordination and planning between DOE and its regulatory entities have not always taken place. For example, at the Paducah plant, regulators have recently expressed concern that DOE has excluded them from the planning process for both the overall cleanup approach and specific projects.

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Recommendation	Status	Action taken
Focus of recommendation: recycling/waste disposal		
DOE should develop an integrated, optimized waste management plan that encompasses material reuse, recycling, packaging, transport, and waste disposal. Consistent with cost reduction and public health and environmental protection, materials should be cleaned to free-release standards and released to the commercial sector for recycling. Material that cannot be cleaned to free-release standards should be considered for recycling within DOE or Department of Defense complexes in applications where slightly contaminated materials are acceptable, such as for shield blocks or waste containers.	Addressed	In 1997, DOE established the National Center of Excellence for Metals Recycle as a DOE complexwide resource for pursuing recycling and reuse alternatives for scrap equipment and surplus materials. The center has reported a reuse savings for the three plant sites of approximately $28 million since its establishment. However, in 2000, DOE suspended the release of scrap metals, such as nickel, copper, and aluminum, for recycling because of public concern that radioactive contamination might remain on or in the scrap metal. As a result, the plants are currently stockpiling or disposing of potentially valuable metals. For example, about 15,500 tons of scrap nickel—a valuable industrial commodity—salvaged from the Oak Ridge and Paducah plants have been stockpiled and are awaiting disposition. If recycled, DOE could earn between $42 million to $108 million, while disposal of the Oak Ridge plant's nickel stocks alone are estimated to cost DOE about $10 million in transportation and disposal costs. DOE is currently reassessing its recycling policies to determine if scrap metals can be safely recycled.
The committee recommends that, if consistent with the prioritized cost- and risk-reduction process, the depleted uranium hexafluoride should be converted to the more stable chemical form, uranium oxide, for storage or disposal.	Addressed	DOE recently awarded a contract to construct and operate depleted uranium hexafluoride conversion facilities at the Paducah and Portsmouth plants. DOE has begun shipping the depleted uranium hexafluoride cylinders currently stored at the Oak Ridge plant to Portsmouth for conversion.

Source: GAO analysis of DOE information.

Comments from the Department of Energy

The Under Secretary of Energy
Washington, DC 20585

June 15, 2004

Ms. Robin M. Nazzaro
Director, Natural Resources
and Environment
United States General Accounting Office
Washington, DC 20548

Dear Ms. Nazzaro:

We have reviewed your draft report entitled *URANIUM ENRICHMENT – Decontamination and Decommissioning Fund is Insufficient to Cover Cleanup Costs.* The report, with some corrections, accurately presents the current status of the Fund. Due to the complexity of the Government Accounting Office (GAO) financial models, the Department of Energy (DOE) was unable to independently validate the results. The DOE's agreement, therefore, with the recommendations contained in this report is based upon the assumption that the financial analysis is accurate.

The Department concurs with the GAO's recommendation that Congress consider the reauthorization of the Fund for an additional three years and requires DOE to reassess the Fund's sufficiency before it expires to determine if further extensions will be necessary.

DOE does have in place appropriate cleanup plans for the current requirements. DOE will at the appropriate time, develop plans for the Decontamination and Decommissioning of the remainder of the facilities at Paducah and Portsmouth. Enclosed are our specific comments to clarify statements within the report.

If you have any further questions, please call me at (202) 586-7709 or Ms. Barbara Heffernan, Acting Deputy Assistant Secretary for Business Operations, (202) 586-5314.

Sincerely,

David K. Garman
Acting Under Secretary for Energy,
Science and Environment

Enclosure

cc:
S. McDonald, GAO

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Staff Acknowledgments

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