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NUCLEAR WASTE CLEANUP

Preliminary Observations on DOE's Cleanup of the Paducah Uranium Enrichment Plant

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Natural Resources and Environment

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Highlights

Highlights of GAO-04-278T, testimony before the Committee on Energy and Natural Resources, U.S. Senate

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Why GAO Did This Study

In 1988, radioactive contamination was found in the drinking water wells of residences located near the federal government's uranium enrichment plant in Paducah, Kentucky, which is still in operation. In response, the Department of Energy (DOE) began a cleanup program to identify and remove contamination in the groundwater, surface water, and soil located within and outside the plant. In 2000, GAO reported that DOE faced significant challenges in cleaning up the site and that it was doubtful that the cleanup would be completed as scheduled by 2010, and within the $1.3 billion cost projection.

GAO was asked to testify on (1) how much DOE has spent on the Paducah cleanup and for what purposes, and the estimated total future costs for the site; (2) the status of DOE's cleanup effort; and (3) the challenges DOE faces in completing the cleanup.

This testimony is based on ongoing work, and GAO expects to issue a final report on this work in April 2004.

What GAO Found

Since 1988, DOE has spent $823 million, adjusted to fiscal year 2002 constant dollars, on the Paducah cleanup program. Of this total, DOE spent $372 million (45 percent) for a host of operations activities, including general maintenance and security; $298 million (36 percent) for actions to clean up contamination and waste; and almost $153 million (19 percent) for studies to assess the extent of contamination and determine what cleanup actions were needed. DOE currently projects that the cleanup will take until 2019 and cost $2 billion to complete—nine years and $700 million more than its earlier projection. The $2 billion, however, does not include the cost of other DOE activities required to close the site after the uranium enrichment plant ceases operations, including final decontamination and decommissioning of the plant and long-term environmental monitoring. DOE estimates these activities will bring the total cost to over $13 billion through 2070.

DOE has made some progress in cleaning up contamination and waste at Paducah, but the majority of the work remains to be done. For example, while DOE has removed over 4,500 tons of scrap metal, over 50,000 tons of contaminated scrap metal remain. Similarly, while DOE's pilot test of a new technology for removing the hazardous chemical trichloroethylene (TCE) from groundwater at the site had promising results, the technology will not be fully implemented for over a year.

DOE's key challenge in completing the Paducah cleanup is achieving stakeholder agreement on the cleanup approach. For example, differences between DOE and the regulatory entities—the Commonwealth of Kentucky and the U.S. Environmental Protection Agency—over the cleanup scope and time frames resulted in an almost 2-year dispute, from June 2001 to April 2003, that disrupted progress. All three parties are working to develop an accelerated cleanup plan, but continued cooperation will be required in order to advance the cleanup.

Drum Mountain, 2,500 tons of crushed drums that once held depleted uranium, and the site after its removal in 2000.

Before After

Source: DOE.

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Senator Bunning:

We are pleased to be here today to discuss the Department of Energy's (DOE) efforts to clean up contamination and waste at its Paducah, Kentucky, uranium enrichment plant. The plant, which continues to operate under a lease to a private company, the United States Enrichment Corporation (USEC), enriches uranium for commercial nuclear power plants. DOE began a cleanup program at the site in 1988, after contaminated groundwater was found in nearby residents' drinking water wells, and contaminated surface water and soils were identified within and outside the site. In August 1999, in response to allegations that past plant activities had endangered employees' health, DOE's Office of Oversight conducted an independent investigation that identified improper disposal of hazardous and radioactive materials on- and off-site and the release of contaminated water into streams and drainage ditches.[1] In 2000, prompted by continuing congressional concerns, we reported that DOE faced significant challenges, such as obtaining stakeholder concurrence with its approach in cleaning up the Paducah site and that it was doubtful that the cleanup would be completed as scheduled by 2010 and within the $1.3 billion cost projection.[2] Our statement today describes the preliminary results of our ongoing work, directed by the conference report for DOE's 2003 appropriations, on DOE's cleanup efforts at the Paducah plant.[3] Specifically, we will discuss (1) how much DOE has spent on the cleanup program and for what purposes, and the estimated total future costs for the site; (2) the status of DOE efforts to clean up the contamination at the site; and (3) the challenges DOE faces in completing the cleanup.

In summary:

- Since 1988, DOE has spent $823 million, adjusted to fiscal year 2002 constant dollars, on the Paducah site. Of this total, DOE spent about $372 million (45 percent) to pay for operations at the site, including construction, security, general maintenance, and litigation; $298 million

[1]Department of Energy, Office of Oversight, Office of Environment, Safety, and Health, *Phase I: Independent Investigation of the Paducah Gaseous Diffusion Plant* (Washington, D.C., Oct. 1999).

[2]U.S. General Accounting Office, *Nuclear Waste Cleanup: DOE's Paducah Plan Faces Uncertainties and Excludes Costly Cleanup Activities*, GAO/RCED-00-96 (Washington, D.C.: Apr. 28, 2000).

[3]H.R. Conf. Rep. No. 108-10, at 895 (2003).

(36 percent) on actions to clean up contamination and remove waste; and almost $153 million (19 percent) for studies to assess the extent of the contamination and determine what cleanup actions were necessary. Although DOE estimated in January 2000 that the cleanup would be complete by 2010 and cost $1.3 billion, DOE now estimates that completing the cleanup will take at least until 2019 and cost almost $2 billion. The $2 billion, however, does not include the cost of other DOE activities required to close the site, including final decontamination and decommissioning of the buildings, equipment, and materials used in the uranium enrichment process after operations cease at the plant, as well as long-term environmental monitoring at the site. Completing these activities will bring the total cost of closing the uranium enrichment plant to over $13 billion through 2070.

- DOE has made some progress in cleaning up contamination and waste at Paducah since 1988, but much of the work remains to be done. For example, DOE has removed over 4,500 tons of scrap metal, but over 50,000 tons remain. Similarly, although DOE has tested a new technology for removing the hazardous chemical trichloroethylene (TCE) from groundwater at the site with promising results, the test removed only about 1 percent of the estimated amount of TCE, and the technology will not be fully implemented for over a year. DOE also plans to conduct a number of studies to determine if other cleanup actions, in addition to those already planned, are necessary. For example, DOE will test the groundwater near several areas where waste is buried to determine if contamination is leaking and, if so, what corrective action will be needed.

- DOE's key challenge in completing the cleanup at Paducah is achieving stakeholder agreement on the cleanup approach, including scope and time frames. For almost 2 years, from June 2001 to April 2003, DOE and the regulators—the U.S. Environmental Protection Agency (EPA) and the Commonwealth of Kentucky—were unable to agree on cleanup scope and time frames, disrupting cleanup progress. DOE, EPA, and Kentucky are currently negotiating approval of an accelerated cleanup plan; however, the success of the plan will depend on the parties' ability to agree on the scope and time frames for individual projects as the cleanup moves forward. In addition, DOE's proposed plan is only the latest of several attempts to resolve problems at the site since 1999. Given the parties' past difficulties in resolving disputes over cleanup scope and time frames, and the number of decisions that remain to be made, it is unclear whether DOE will be successful in accelerating the cleanup.

Background

The Paducah uranium enrichment plant is located on about 3,500 acres in western Kentucky, about 3 miles south of the Ohio River and about 10 miles west of the city of Paducah. The plant—formerly operated by DOE and now operated by USEC—enriches uranium for commercial nuclear power reactors. Plant operations have contaminated the site over time with radioactive and hazardous chemical wastes, including technetium-99 (a radioactive fission product); polychlorinated biphenyls (PCBs); uranium; and volatile organic compounds such as TCE, which was used as a degreaser.

Responsibility for management of the Paducah site is divided between two DOE offices. The Office of Environmental Management has overall responsibility for the site cleanup being performed by its contractor, Bechtel Jacobs. The Office of Nuclear Energy acts as the site's landlord, with responsibilities for maintaining roads, grounds, and facilities not leased to USEC.

EPA and Kentucky cooperate in regulating the cleanup under the federal facility agreement, which integrates the requirements of two federal environmental statutes governing the cleanup of the Paducah site—the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, and the Resource Conservation and Recovery Act of 1976, as amended. Respectively, these statutes provide broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment and to regulate the safe management and disposal of hazardous or other solid wastes.

In addition to the federal facility agreement, DOE uses two other documents to manage the cleanup. The site management plan, which is a cleanup strategy document developed annually by DOE and subject to approval by EPA and Kentucky, includes timetables, deadlines, and projected activities for the cleanup. DOE uses the lifecycle baseline to manage the cleanup; it contains detailed information on cleanup projects, cost estimates, and time frames for completion and is updated frequently by DOE's contractor to reflect the evolving nature of the cleanup process.

DOE's cleanup plan for the Paducah site divides the cleanup into seven major categories:

- Groundwater—About 10 billion gallons of groundwater are contaminated with radioactive and hazardous materials.

- Surface water—Contaminated surface water has been discovered in creeks and ditches leaving the site. One of the main sources of this contamination is rain runoff from the thousands of tons of contaminated scrap metal stored at the site.

- Surface soils—Both on- and off-site soils and sediments have been contaminated by water runoff, spills, and buried waste.

- Legacy waste—Low-level radioactive or hazardous waste generated before 2001 remains stored in various locations at the site.

- DOE material storage areas—160 indoor and outdoor storage areas contain a variety of radioactive, hazardous, and other materials. These areas have been added to the cleanup scope since our 2000 report.

- Burial grounds—12 burial grounds contain a variety of waste, including barrels of materials with low levels of radioactivity and hazardous chemicals.

- Decontamination and decommissioning of 17 unused buildings and structures—These facilities were contaminated during earlier operations; 15 have been added to the cleanup scope since our 2000 report.

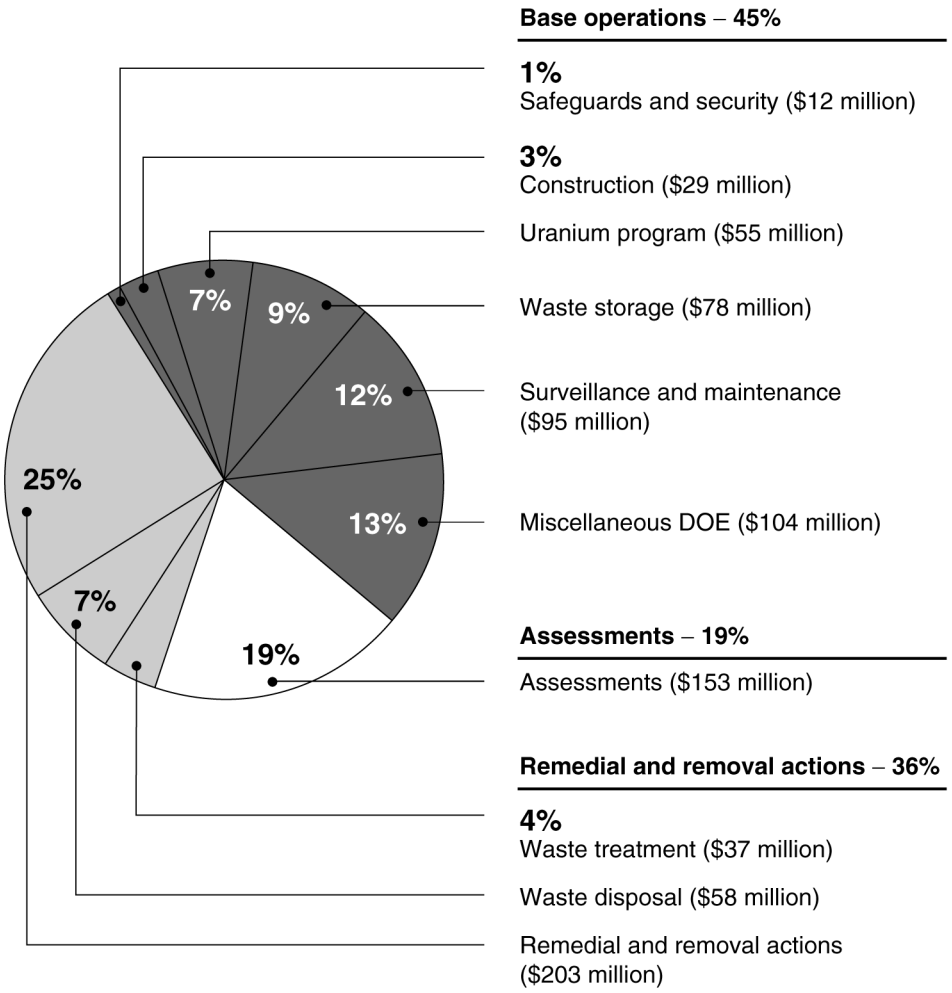
DOE Has Spent $823 Million on the Paducah Cleanup Program, and Billions More Will be Required for Final Site Closure

From 1988 through 2003, DOE spent $823 million, adjusted to fiscal year 2002 constant dollars, at the Paducah site. As figure 1 shows, $372 million (45 percent) was spent on operations at the site such as providing security, performing general maintenance, providing municipal water for nearby residents, maintaining almost 38,000 cylinders of depleted uranium hexafluoride,[4] constructing storage and other facilities, and carrying out activities related to litigation; $298 million (36 percent) was spent on cleanup actions, including waste removal and treatment; and $153 million (19 percent) was spent on studies to assess the contamination and determine what cleanup actions were necessary. These percentages are similar to those DOE's Office of Environmental Management found for all of its cleanup programs: only about one-third of the environmental management program budget goes toward actual cleanup and risk reduction work, with the remainder going to maintenance, fixed costs, and miscellaneous activities, contributing to a lack of risk reduction and raising costs for DOE's cleanups.[5]

[4]Uranium hexafluoride, a byproduct of the uranium enrichment process, must be handled in leakproof containers because when it comes into contact with water, such as water vapor in the air, it forms corrosive hydrogen fluoride and a uranium-fluoride compound called uranyl fluoride.

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

Figure 1: Expenditures at Paducah by Category, Fiscal Years 1988-2003



Source: GAO analysis of DOE data.

Note: Total cleanup expenditures for fiscal years 1988-2003, adjusted to fiscal year 2002 dollars, were $823 million. The individual dollar figures noted above may not total $823 million because of rounding.

DOE's current estimate for completing the cleanup is almost $2 billion—a $700 million increase over its 2000 estimate—and the completion date has moved from 2010 to 2019. The cost increase is attributable to an expanded project scope as well as millions of dollars for site operations for each of the 9 additional years of cleanup. However, the cleanup estimate does not represent DOE's total responsibilities at the site: In addition to the cleanup program, DOE will build and operate a facility to convert the depleted uranium hexafluoride stored at the site to a more stable form and carry

out final decontamination and decommissioning (D&D) of the uranium enrichment process buildings, equipment, and materials once USEC ceases plant operations. Furthermore, after the cleanup, D&D, and uranium hexafluoride conversion, DOE will continue to incur long-term stewardship costs at the site for such activities as monitoring groundwater and surface water for residual contamination. Completing these activities will bring the total cost of closing the uranium enrichment plant to over $13 billion through 2070.

While DOE Has Made Some Progress, the Bulk of the Cleanup Remains

Since 1988, DOE has made some progress in cleaning up the contamination and waste at Paducah, but much of the cleanup work remains to be done. Some of DOE's accomplishments since our 2000 report as well as tasks remaining follow:

- Groundwater—DOE has treated about 710 million gallons of groundwater to remove TCE and technetium-99 and prevent off-site contamination. DOE's pilot test of technology for removing TCE sources—large concentrations of accumulated TCE—had promising results. However, the test removed only about 1 percent of the estimated 180,000 gallons of TCE that had leaked into the ground, and the system will not be fully implemented until at least 2005, according to DOE contractor officials.[6] The estimated completion date for removing TCE from the two major sources at the site is 2010.

- Surface water—To prevent contaminated runoff, DOE has removed about 4,500 tons of scrap metal from the site—primarily crushed drums that previously had contained uranium and aluminum ingots. An estimated 50,500 tons of scrap metal remains to be removed from the site. At the north-south diversion ditch, a key wastewater conduit from the plant, surface water discharges and runoff have been rerouted and piped to bypass contaminated areas, and DOE has begun excavation work to remove contaminated soil from the first of five sections of the ditch. DOE plans to complete excavation of sections one and two by 2005. The estimated completion date for all surface water cleanup activities is 2017.

[6]According to DOE, this estimate is based on the assumptions that TCE was used at the site from 1953 to 1993 and that a fixed amount was released to the ground each day. A high degree of uncertainty surrounds this estimate, and the actual amount of TCE released cannot be verified.

- Surface soils—DOE has assessed all surface soils at the site to identify radioactive contamination and protect plant workers. In addition, DOE has removed 2,500 cubic yards of contaminated soils—enough to cover a football field 17 inches deep. However, because soil contamination represents a lower risk for exposure and migration than, for example, groundwater, and because other work, such as removal of scrap metal, must be performed before some soils can be reached, this category is a lower priority. DOE estimates that a total of 90,000 cubic yards of soils will be removed and disposed by 2015.
- Legacy waste—DOE has performed initial characterization of all of this waste—the equivalent of 52,000 55-gallon barrels—for on-site storage, and disposed of over 7,000 barrels off-site. Another 6,000 have been repackaged and are ready for disposal. The remaining legacy waste—over 38,000 barrels—will be characterized and disposed of by 2010.

- DOE material storage areas (DMSA)—DOE has ranked the 160 DMSAs at the Paducah site on the basis of their potential to contain hazardous materials or contaminate the environment: 33 are high priority, 11 are medium priority, and 116 are low priority. DOE has characterized and removed materials from 9 high- and 15 low-priority DMSAs and has completed characterization of an additional 17 high-priority DMSAs. DOE still needs to remove materials from these 17 and characterize and remove materials in the remaining 119 DMSAs. According to DOE officials, only 0.01 percent of the materials characterized to date have been determined to be hazardous waste. DOE plans to complete characterization by the end of fiscal year 2009 and dispose of all materials from the DMSAs by 2013.

- Burial grounds—To date, DOE's activities at the 12 burial grounds have consisted of studies and environmental monitoring and maintenance. Currently, DOE plans to cap—cover with a layer of soil—the burial grounds and monitor groundwater to evaluate the effectiveness of the caps. If the burial grounds are found to be leaking TCE or other hazardous substances, some burial grounds may need to be excavated. Groundwater monitoring will be ongoing through 2019.

- Decontamination and decommissioning of 17 buildings and structures that are no longer used for the uranium enrichment process—DOE has completed its assessment of the contamination and has begun removing the infrastructure of one of the buildings. The remaining 16 are scheduled to be completed by 2017.

After operations cease at the plant, DOE will decontaminate and decommission the uranium enrichment process buildings and equipment. [7] During D&D, DOE will also address, as necessary, those areas where additional studies are being done.

Reaching Agreement on Cleanup Scope and Time Frames Remains the Key Challenge to Cleanup Progress

DOE's most difficult challenge has been, and could likely remain, obtaining stakeholder agreement on the cleanup approach, including scope and time frames. According to DOE officials, reaching agreement has been more difficult at Paducah than at other DOE cleanup sites. For example, from June 2001 to April 2003, DOE, EPA, and Kentucky were in dispute over the 2001 site management plan because they could not agree on the cleanup scope and time frames. Specifically, in response to congressional concern about the lack of cleanup progress prior to hearings held in 1999, DOE, Kentucky, and EPA drafted a site management plan to expedite cleanup actions at the site. According to Kentucky officials, technical staff of all three parties agreed to this plan. However, DOE headquarters officials later abandoned the plan, citing budgetary constraints and their belief that the risk did not warrant all the planned cleanup actions.

DOE and Kentucky have also had difficulty agreeing on the details of specific cleanup projects. For example, it took the two parties 5 months to reach agreement on the amount and type of data required to confirm that soil from the north-south diversion ditch could be appropriately disposed of in an onsite landfill. DOE and Kentucky also had difficulties resolving DOE's regulatory violations at the site, which, according to DOE officials, slowed cleanup progress.

DOE and the regulators have recently resolved a number of differences that were delaying cleanup actions. For example, in October 2003 DOE and Kentucky agreed to a settlement that resolved outstanding regulatory violations related to, among other things, DOE's management of hazardous waste at the site. In addition, all three parties are currently negotiating approval of the 2004 site management plan, which will provide a framework for accelerating the cleanup. While we are encouraged by these recent events, the success of the plan, once approved, will depend on the parties' ability to reach agreement on the scope and time frames for individual projects as the cleanup moves forward. Furthermore,

[7] No schedule currently exists for full-scale D&D of the operating plant.

agreement on an accelerated cleanup plan may not preclude future disputes between DOE and the regulators. For example, DOE and the state of Washington have had an accelerated plan in place since March 2002, but they only recently completed a lengthy negotiation over time frames for disposal of mixed radioactive and toxic wastes at the Hanford cleanup site.

In addition, as table 1 shows, the accelerated cleanup plan will be only the latest of several cleanup plans for the site since 1999, all of which have differed significantly in cost, scope, and time frame for cleanup and were intended as solutions to problems at the site. For example, DOE's Assistant Secretary for Environmental Management testified in July 2000 that a solid and effective working relationship had been established with Kentucky and EPA and a process was in place that would lead to mutually supported cleanup decisions.[8] Ten months later, DOE was in dispute with the regulators over the site management plan.

Table 1: DOE Estimates of Paducah Plant Cleanup Costs and Completion Schedule

Dollars in billions

Date and source of DOE estimate	Estimated cleanup cost	Estimated completion date
October 1999 appropriations hearing	$0.7	2012
January 2000 lifecycle baseline	1.3	2010
Amended fiscal year 2003 site management plan	2.5	2030
Fiscal year 2004 site management plan	2.0	2019

Sources: GAO and DOE.

Given DOE's past difficulties in reaching agreement with its regulators and the details that remain to be agreed upon, it is unclear whether DOE will be successful in accelerating the cleanup.

These are our observations to date. We will continue to further assess DOE's progress and challenges in cleaning up the Paducah site and plan to issue our final report in April 2004.

[8]July 12, 2000, testimony of Dr. Carolyn Huntoon before the House Budget Committee Task Force on Natural Resources and the Environment.

Thank you, Senator Bunning. This concludes my prepared statement. I will be pleased to respond to any questions that you may have.

Contact and Acknowledgments

For further information on this testimony, please contact me at (202) 512-3841. Individuals making key contributions to this testimony included Nancy Crothers, Chris Ferencik, Kerry Dugan Hawranek, Kurt Kershow, and Sherry McDonald.

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