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Report to the Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives

September 2010

NUCLEAR WASTE

Actions Needed to Address Persistent Concerns with Efforts to Close Underground Radioactive Waste Tanks at DOE's Savannah River Site

GAO-10-816

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Highlights

Highlights of GAO-10-816, a report to the Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives

Why GAO Did This Study

Decades of nuclear materials production at the Department of Energy's (DOE) Savannah River Site in South Carolina have left 37 million gallons of radioactive liquid waste in 49 underground storage tanks. In December 2008, DOE entered into a contract with Savannah River Remediation, LLC (SRR) to close, by 2017, 22 of the highest-risk tanks at a cost of $3.2 billion. GAO was asked to assess: (1) DOE's cost estimates and schedule for closing the tanks at the Savannah River Site, and (2) the primary challenges, if any, to closing the tanks and the steps DOE has taken to address them. GAO visited the Savannah River Site and reviewed tank closure documents, as well as conducted an analysis of the construction schedule of the Salt Waste Processing Facility (SWPF), which is a facility vital to successful tank closure because it will treat a large portion of the waste removed from the tanks.

What GAO Recommends

GAO is making five recommendations to DOE to, among other things, clarify how cost increases should be requested by a contractor, as well as reviewed and approved by DOE and to ensure the SWPF construction schedule conforms to best practices. Although DOE generally agreed with two of our recommendations, they disagreed on the necessity of additional clarity on how cost increases should be requested by a contractor and that the SWPF construction schedule did not conform to best practices. We continue to believe our recommendations are valid.

View GAO-10-816 or key components. For more information, contact David C. Trimble at 202-512-3841 or trimbled@gao.gov.

What GAO Found

Emptying, cleaning, and permanently closing the 22 underground liquid radioactive waste tanks at the Savannah River Site is likely to cost significantly more and take longer than estimated in the December 2008 contract between DOE and SRR. Originally estimated to cost $3.2 billion, SRR notified DOE in June 2010 that the total cost to close the 22 tanks had increased by more than $1.4 billion or 44 percent. Much of this increase is because DOE's cost estimate in the September 2007 request for proposals that formed the basis of the December 2008 contract between DOE and SRR was not accurate or comprehensive. For example, DOE underestimated the costs of labor and fringe benefits. DOE also omitted certain other costs related to equipment and services needed to support tank closure activities. Moreover, more than $600 million of this increase is due to increased funding needed to make up for significant losses suffered by Savannah River Site workers' pension plans as a result of the recent economic crisis. Closing the tanks may also take longer than originally estimated because of persistent delays and shortcomings in the construction schedule for SWPF. According to SRR, construction delays that have already occurred will result in between 2 and 7 fewer tanks being closed by 2017 than agreed to in the contract. Furthermore, the SWPF construction schedule does not fully meet GAO-identified best scheduling practices. For example, the schedule had problems with excess float time between activities, indicating that the schedule's activities may not be sequenced logically. DOE is exploring ways to mitigate the effects of construction delays by deploying new technologies to treat radioactive waste. However, additional research and development on these new technologies is still required and, therefore, it will be several years before they are deployed.

DOE officials identified three primary challenges to closing the liquid radioactive waste tanks at the Savannah River Site:

- on-time construction and successful operation of SWPF;
- increasing the amount and speed at which radioactive waste is processed at the Savannah River Site's Defense Waste Processing Facility, which prepares the waste for permanent disposal by mixing it with molten glass and then pouring it into large metal canisters where it hardens; and
- successful implementation of an enhanced chemical cleaning process that will remove residual waste from the tanks with minimal creation of additional waste that must be treated.

DOE officials identified steps the department is taking to ensure these challenges are met. However, several factors raise concerns about whether DOE will be able to resolve them. For example, the enhanced chemical cleaning process that is a cornerstone of SRR's ability to close tanks on time has never been used in liquid radioactive waste tanks and, according to SRR officials, DOE has not consistently funded additional research and development on the technology. Most experts GAO spoke with were generally confident of DOE's ability to successfully overcome these challenges, although some of them identified additional concerns. For example, some experts suggested that DOE has not engaged in sufficient contingency planning in the event that the department's chosen waste removal, treatment, and tank closure strategies are unsuccessful.

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Abbreviations

ARP/MCU	Actinide Removal Process/Modular Caustic-Side Solvent Extraction Unit
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
EPA	Environmental Protection Agency
SRR	Savannah River Remediation, LLC
SWPF	Salt Waste Processing Facility

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United States Government Accountability Office
Washington, DC 20548

September 14, 2010

The Honorable Peter J. Visclosky
Chairman
The Honorable Rodney P. Frelinghuysen
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
House of Representatives

The Department of Energy's (DOE) Savannah River Site, located on nearly 310 square miles in southwestern South Carolina, was built in the 1950s to produce nuclear materials such as tritium and plutonium that were needed to manufacture nuclear weapons. It did so by dissolving highly radioactive spent nuclear fuel from the site's nuclear reactors in large, heavily shielded separation facilities known as canyons. Decades of nuclear weapons production have left a legacy of radioactive and hazardous waste to be cleaned up at the Savannah River Site, including 37 million gallons of highly radioactive liquid waste that is currently stored in 49 underground storage tanks.[1] Many of these tanks have a history of leakage and 8 are sitting near or below the water table, raising concerns that radioactive and hazardous waste in the tanks could leak into the groundwater and endanger worker safety, public health, and the environment.

In 1993, DOE, the Environmental Protection Agency (EPA), and the South Carolina Department of Health and Environmental Control entered into an agreement that, among other things, called for DOE to empty, clean, and permanently close 22 underground tanks that lack secondary containment—such as tanks that are not double walled or that do not have an external liner—by 2022. DOE has committed to removing waste from the remaining 27 tanks by 2028. Since then, DOE closed 2 tanks in 1997, and finished removing the waste from 2 other tanks in 2009. In December 2008, DOE awarded an 8-year tank closure contract to Savannah River Remediation, LLC (SRR).[2] Under this contract, SRR committed to an accelerated schedule of emptying, cleaning, and closing the 22 tanks

[1]There are a total of 51 tanks at the Savannah River Site, 2 of which have already been emptied and closed.

[2]The contract period of performance consists of a 3-month transition period, a 6-year base term, and a 2-year option period.

without secondary containment by 2017, 5 years before the date in the agreement between DOE, EPA, and South Carolina at a cost of $3.2 billion.

In this context, you asked us to assess (1) DOE's current cost estimates and schedule for closing the liquid radioactive waste tanks at the Savannah River Site, and (2) the primary challenges, if any, to closing the liquid radioactive waste tanks and the steps DOE has taken to address them.

To address these objectives, we reviewed DOE's initial tank closure cost estimates, the December 2008 contract between DOE and SRR, and SRR's revised cost estimates. We also used GAO-identified best practices from across industry and government to review the construction schedule for a facility that will be used to treat a majority of the tank waste volume.[3] In addition, we interviewed DOE officials at the Savannah River Site and in Washington, D.C., as well as officials from SRR, EPA, and South Carolina. To assess the primary challenges to closing the tanks, we interviewed DOE officials and asked them to identify such challenges and steps taken. We also reviewed tank closure plans and risk management documents, toured Savannah River Site facilities relevant to tank closure, and received briefings from DOE and SRR officials on the liquid radioactive waste system to gain an understanding of these challenges and how DOE planned to address them. In addition, we interviewed 11 experts and solicited their views on the primary tank closure challenges. We selected these experts on the basis of their extensive knowledge of tank closure-related activities. Appendix I contains additional information on our scope and methodology.

We conducted this performance audit from June 2009 to September 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[3]These practices are found in GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

Background

DOE's December 2008 contract with SRR to empty, clean, and close the Savannah River Site's underground tanks is a cost plus award fee contract. Under this type of contract, SRR's costs to conduct cleanup work are reimbursed by DOE. Such costs include, among other things, workers' salaries and fringe benefits such as employer-provided health insurance and defined-benefit pension plans. In addition, to encourage innovative, efficient, and effective performance, this type of contract gives SRR the opportunity to earn a monetary incentive known as an award fee. The amount of award fee SRR is able to earn is determined by its accomplishment of goals mutually agreed upon by the contractor and DOE. The contractor's cost, schedule, performance, and scope commitments for successfully delivering the contract-defined requirements are specified in a document known as the contract performance baseline that is developed by the contractor and agreed to by DOE. Many site activities not related to tank closure—such as management of spent nuclear fuel and soil and groundwater cleanup—are conducted under a separate management and operations contract currently held by Savannah River Nuclear Solutions, LLC.

DOE Order 413.3A establishes a process for managing the department's major projects—including contractor-run projects that build large complexes that often house unique equipment and technologies such as those that process waste or other radioactive material and environmental cleanup projects. The order covers activities from identification of need through project completion.[4] Specifically, the order establishes five major milestones—or critical decision points—that span the life of a project. Order 413.3A specifies the requirements that must be met, along with the documentation necessary, to move a project past each milestone. In addition, the order requires that DOE senior management review the supporting documentation and approve the project at each milestone. DOE also provides suggested approaches for meeting the requirements contained in Order 413.3A through additional guidance.

For years, DOE has had difficulty managing its contractor-run projects. Despite repeated recommendations from us and others to improve project management, DOE continues to struggle to keep its projects within their cost, scope, and schedule estimates. For example, we reported in September 2008 that 9 of 10 major cleanup projects managed by DOE's

[4]DOE Order 413.3A was approved in 2006, and changed in 2008. This order canceled DOE Order 413.3, which was issued in 2000.

Office of Environmental Management—which manages cleanup projects such as tank closure at the Savannah River Site—had experienced cost increases, and that DOE had estimated that it needed an additional $25 billion to $42 billion more than the projects' initial cost estimates to complete these projects.[5] Because of DOE's history of inadequate management and oversight of its contractors, we have included contract and project management in DOE's National Nuclear Security Administration and Office of Environmental Management on our list of government programs at high risk for fraud, waste, abuse, and mismanagement since 1990.[6]

In response to its continued presence on our high-risk list, DOE analyzed the root causes of its contract and project management problems in 2007 and identified several major findings.[7] Specifically, DOE found that the department:

- often does not complete front-end planning to an appropriate level before establishing project performance baselines;
- does not objectively identify, assess, communicate, and manage risks through all phases of project planning and execution;
- fails to request and obtain full project funding;
- does not ensure that its project management requirements are consistently followed; and
- often awards contracts for projects prior to the development of an adequate independent government cost estimate.

To address these issues and improve its project and contract management, DOE has prepared a corrective action plan with various corrective measures to track its progress.[8] Among the measures being implemented

[5]GAO, *Nuclear Waste: Action Needed to Improve Accountability and Management of DOE's Major Cleanup Projects*, GAO-08-1081 (Washington, D.C.: Sept. 26, 2008).

[6]GAO, *High Risk Series: An Update*, GAO-09-271 (Washington, D.C.: January 2009).

[7]DOE, *Root Cause Analysis: Contract and Project Management* (Washington, D.C., April 2008).

[8]DOE, *Root Cause Analysis Contract and Project Management Corrective Action Plan* (Washington, D.C., 2008).

are for DOE to make greater use of third-party reviews prior to project approval, establish objective and uniform methods of managing project risks, better align cost estimates with anticipated budgets, and establish a federal independent government cost-estimating capability.

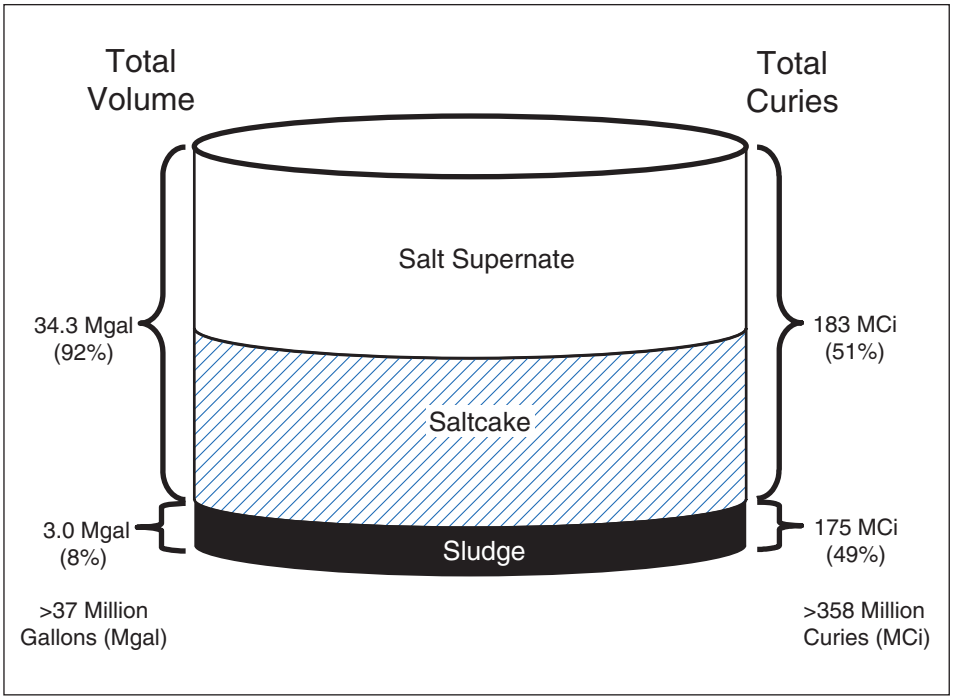
Emptying, cleaning, and closing the 22 tanks without secondary containment involves a number of steps. The radioactive waste generally comes in a variety of physical forms and layers inside the tanks, depending on the physical and chemical properties of the waste components. The waste in the tanks take the following three main forms which are illustrated in figure 1:

- *Sludge.* The denser, water-insoluble components of the waste generally settle to the bottom of the tank to form a thick layer known as sludge, which has the consistency of peanut butter. Although sludge is only 8 percent of the total volume of the tank waste at the Savannah River Site, it has about 49 percent of the tanks' total radioactivity.

- *Saltcake.* Above the sludge may be water-soluble components, such as sodium salts, that crystallize or solidify out of the waste solution to form a moist sandlike material called saltcake.

- *Salt supernate.* Above or between the denser layers may be liquids comprised of water and dissolved salts that are called supernate.

Figure 1: Three Types of Waste at the Savannah River Site by Volume and Level of Radioactivity as of March 30, 2010



Source: DOE.

Most of the waste in a tank is removed by using pumps and high-pressure wash systems. Various methods are then used to immobilize the waste and prepare it for permanent disposal. In the case of sludge, the material is immobilized through vitrification—a process that stabilizes waste by mixing it with molten glass and then pouring it into large metal canisters where it hardens—at the Savannah River Site's Defense Waste Processing Facility (DWPF), which has operated since March 1996. Canisters produced by DWPF are currently stored on site pending the availability of a geologic repository where they will be permanently disposed. DOE's original plans were to locate a permanent geologic repository for these canisters, as well as other nuclear waste generated across the United States, at Yucca Mountain in Nevada. The department had submitted a license application for authorization to construct a repository at Yucca Mountain to the U.S. Nuclear Regulatory Commission. However, DOE moved to withdraw the license application in March 2010 and has declared its intention not to proceed with the Yucca Mountain project. While the U.S. Nuclear Regulatory Commission's Atomic Safety and Licensing Board

denied DOE's motion to withdraw the application in June 2010, the final permanent disposal location for vitrified high-level waste at the Savannah River Site, as well as hundreds of thousands of tons of additional radioactive waste across the country, remains in question.

In the case of the larger volumes of saltcake and salt supernate (known collectively as salt waste) that are stored at the Savannah River Site, glass vitrification of all of this waste without reducing its volume would produce a very large number of metal canisters that would need to be permanently disposed. DOE is using several interim processes to separate higher radioactivity waste from the remainder of the lower activity waste and, consequently, reduce the number of canisters requiring disposal that will be generated. One of these interim processes—the Actinide Removal Process/Modular Caustic-Side Solvent Extraction Unit (ARP/MCU)—began operations in May 2008 with a 3-year operational expectancy. DOE is also constructing permanent facilities at the Savannah River Site to separate the higher activity waste from the remainder of the lower activity waste. A key facility, the Salt Waste Processing Facility (SWPF), uses the same technology as ARP/MCU, but on a larger scale. SWPF is currently being constructed by Parsons Corporation under a separate contract with DOE. Although estimated to cost more than $1.3 billion, we reported in January 2010 that DOE's cost estimate for SWPF only somewhat or partially met the four characteristics of high-quality cost estimates—accuracy, comprehensiveness, credibility, and well documented.[9] DOE expects SWPF to begin separating higher- and lower-radioactivity waste sometime between fiscal year 2013 and the beginning of fiscal year 2016. Once separated, higher-radioactivity waste will then be mixed with sludge for vitrification at DWPF. The low-radioactivity waste that is currently separated out by ARP/MCU and is to be separated out by SWPF is stabilized by combining it with a grout-like substance at another Savannah River Site facility called the Saltstone Facility, where it will be permanently disposed of in a series of on-site vaults.

Removal and treatment of liquid radioactive waste from the tanks do not, however, complete the tank closure process. Any residual radioactive waste that pumping and high-pressure washing cannot remove from the tank surfaces must be mechanically scrubbed and may also be treated

[9]GAO, *Department of Energy: Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects*, GAO-10-199 (Washington, D.C.: Jan. 14, 2010).

with chemicals for removal. This cleaning process generates additional radioactive waste that must also be removed from the tanks and eventually treated for permanent disposal. Even with chemical cleaning, it is impossible with current technology to remove 100 percent of the radioactive and hazardous waste from every tank. A small quantity of waste will remain in the tank. Following the removal of most of the waste and chemical cleaning, DOE must demonstrate that the department has cleaned the tank to the maximum extent practicable. DOE, EPA, and South Carolina must agree upon the concentration of wastes that are allowed to remain in the tanks and the criteria for permanently closing them. The current plan calls for DOE to permanently close the tanks by filling the now-substantially empty tanks with a cementlike substance to prevent their collapse and the release of any residual radioactive or hazardous material into the environment.

Based on Current Cost Estimates and Schedule, Closing the Savannah River Site's Tanks Is Likely to Cost More and Take Longer Than Originally Estimated

Emptying, cleaning, and permanently closing the 22 underground liquid radioactive waste tanks at the Savannah River Site that lack secondary containment is likely to cost significantly more and take longer than estimated in the December 2008 contract between DOE and SRR. Specifically, SRR notified DOE in June 2009 that the total cost to close the 22 tanks had increased by slightly more than $1.4 billion from $3.2 billion as estimated in the December 2008 contract to about $4.6 billion. In addition, closing the tanks may take longer than originally estimated because of persistent delays constructing SWPF—a facility vital to successful tank closure because it will treat a large portion of the waste removed from the tanks. Our review also found that the SWPF construction schedule does not meet GAO-identified best scheduling practices. Although DOE is exploring ways to mitigate the effects of SWPF construction delays by deploying new technologies to treat additional quantities of waste, DOE officials told us that additional research and development on these technologies is still required and that it would be several years before these new technologies could be deployed.

SRR Estimates That the Cost to Close 22 Tanks Has Increased 44 Percent

One day before beginning work under the contract it signed with DOE in December 2008, SRR reported that the estimated cost to empty, clean, and permanently close the 22 tanks had increased by slightly more than $1.4 billion. The estimated cost increase was discovered during a due-diligence review SRR conducted during the transition period from the previous contractor managing liquid high-level radioactive waste operations at the Savannah River Site. The purpose of this review was to identify, among other things, any physical site conditions that were different than those

portrayed in DOE's September 2007 request for proposals—which formed the basis of SRR's proposal and the December 2008 contract—or that could give rise to other liabilities or noncompliance with the contract. In a June 30, 2009, letter—one day prior to the end of the contract transition period—SRR reported to DOE that its review had identified more than 300 differences in such conditions, 22 of which SRR considered to be material. Material differences are a change of conditions that will have a significant impact, positive or negative, on the performance of work in terms of time or costs, and impacts to the contract milestones, among other things.

SRR's June 2009 letter stated that these 22 material differences would result in a contract cost increase from roughly $3.2 billion to about $4.6 billion—a 44 percent increase. Our review indicates that much of this increase is because the cost estimate in DOE's 2007 request for proposals that formed the basis of the December 2008 contract was not accurate or comprehensive. For example

- DOE underestimated fringe benefit rates by 27 to 62 percent depending upon an employee's job classification, and underestimated labor rates by 5 to 70 percent for certain job classifications. DOE's cost estimate was based on historical data that underestimated future costs. As a result, SRR reported that costs would increase by $279 million.

- DOE assumed in the September 2007 request for proposals that certain costs—including retiree health care and essential site services such as computer and telecommunications equipment and water service—would be paid under the Savannah River Site's management and operations contract rather than the SRR contract. Subsequently, DOE reversed its decision and instead assigned these costs to the SRR contract. Although this action resulted in no net increase in costs to the taxpayer because these costs will be subtracted from the Savannah River Site's management and operations contract, it resulted in a $270 million increase in the costs associated with the tank closure contract.

In addition, DOE did not account for the more than $600 million in pension costs that were needed to make up for significant losses suffered by the Savannah River Site workers' defined-benefit pension plans as a result of the economic crisis that began in 2007. DOE contractors generally provide their employees with pension plans, health care benefit plans, and other postretirement benefits. DOE reimburses these contractors for the costs of providing pension and postretirement benefits to current and former

employees and their beneficiaries. DOE is ultimately responsible for reimbursing its contractors for the allowable costs of these plans.[10] DOE's September 2007 request for proposals estimated that funding the defined-benefit pension plans for current and retired Savannah River Site workers and their beneficiaries covered under the contract would cost $146 million. However, the economic crisis that began in 2007 caused significant losses to the assets in which the Savannah River Site workers' pension plans had invested. This, combined with other factors, caused DOE to face a significant shortfall in the amount of pension funding originally estimated in the 2007 request for proposals versus what is now estimated to be required. Despite having 17 months between the start of the economic crisis and signing the contract with SRR, DOE did not update the September 2007 pension cost estimate because, according to DOE officials, the amount of the shortfall was still fluctuating. In its June 2009 letter to DOE, SRR estimated that pension costs had increased by more than $600 million, from $146 million to $762 million.

DOE's difficulty producing an accurate and comprehensive cost estimate to empty, clean, and permanently close the 22 tanks is consistent with the department's own findings in its April 2008 root cause analysis of its contract and project management problems. Similarly, we reported in January 2010 that DOE's inability to produce high-quality cost estimates limits the department's ability to effectively manage its projects and provide good estimates to Congress of the amount of money needed to complete projects and recommended that the department update its cost estimating guidance to address these concerns.[11]

DOE took no action in response to SRR's June 2009 letter reporting the 22 material differences and $1.4 billion cost increase. Lacking a response from DOE, SRR prepared and, in September 2009, submitted a contract performance baseline to DOE that included these additional costs. SRR and DOE officials told us that DOE did not inform SRR of department guidance that stated that a contractor should not be allowed to change estimated contract costs by simply including a higher cost in the contract performance baseline. As a result, SRR received no information on DOE's assessment of the cost increases proposed in June 2009 until DOE rejected

[10]GAO, *Department of Energy: Information on Its Management of Costs and Liabilities for Contractors' Pension and Postretirement Benefit Plans*, GAO-08-642R (Washington, D.C.: June 19, 2008).

[11]GAO-10-199.

SRR's September 2009 contract performance baseline in November 2009. DOE rejected the baseline for reasons including that the department needed additional cost and scheduling documentation to validate SRR's cost and schedule estimates.

Since rejecting SRR's contract performance baseline in November 2009, DOE and SRR officials have discussed SRR's proposed cost increases as part of revising the contract performance baseline. Despite about 7 months of discussions, the revised contract performance baseline SRR submitted on June 30, 2010, contained a cost increase of slightly less than $1.4 billion—only $50 million less than the June 2009 cost increase. Therefore, the current estimated cost to close the 22 Savannah River Site tanks is about $4.6 billion—a 44 percent increase from the roughly $3.2 billion in the December 2008 contract.

DOE approved SRR's proposed cost increases and its revised contract performance baseline in August 2010, more than a year after SRR first identified proposed cost increases. DOE's primary guidance on contract performance baseline development contains limited information detailing the process and time frames by which baselines are to be reviewed and approved.[12] As such, there is no DOE-wide guidance that establishes milestones for reviewing and approving contract performance baselines.

Oversight of contractor performance may also be complicated because DOE has exempted many tank closure activities at the Savannah River Site—as well as many other ongoing environmental cleanup projects—from the full requirements of DOE Order 413.3A. In general, Order 413.3A applies to capital asset acquisition projects, including environmental cleanup projects, having a total cost of $20 million or more. Accordingly, DOE's contract with SRR originally required that the project be managed in accordance with Order 413.3A. In addition, when DOE rejected SRR's initial contract performance baseline, the department found multiple instances in which SRR had not fully satisfied project management provisions contained in Order 413.3A. However, following the completion of the contract with SRR, DOE's Office of Environmental Management evaluated the scope of its contracts to determine how much of the activity actually constituted capital asset acquisition activity. As a result of this evaluation, DOE determined that some of the activities covered by the contract with SRR included both capital asset projects and operating

[12]DOE, *Performance Baseline Guide*, DOE G 413.3-5 (Washington, D.C., Sept. 12, 2008).

activities. DOE exempted these operating activities from Order 413.3A. DOE officials explained that Order 413.3A is more focused on managing the process by which the department constructs new facilities rather than the process by which it operates existing facilities, such as to complete environmental cleanup efforts. While DOE issued a contract modification removing references to Order 413.3A for exempted activities, the modification does not specify which DOE project management policies, if any, apply to the exempted SRR activities. We have previously reported that it is critically important that DOE develop and implement a rigorous, disciplined approach for managing projects, because major cleanup projects, such as tank closure activities at the Savannah River Site, take years to complete, and often involve unique challenges and a high degree of complexity.[13] Such an approach includes planning and managing work activities, cost, and schedule to achieve project goals in a stable, controlled manner.

SWPF Construction Schedule Delays Could Jeopardize DOE's Tank Closure Schedule

Because salt waste makes up more than 90 percent of the volume of liquid radioactive waste at the Savannah River Site, successful construction of the SWPF is vital to DOE's efforts to empty, clean, and permanently close the site's underground tanks. However, SWPF has experienced multiple delays since design of the facility began in 2004. Originally estimated to begin operating in 2009, the facility's startup date has been repeatedly delayed.[14] At the time the contract between DOE and SRR was signed in December 2008, SWPF was expected to begin operations in September 2012. However, DOE subsequently delayed SWPF's expected startup date to May 2013 at the earliest. DOE also added more than 2 years of contingency time to the SWPF construction schedule, meaning that SWPF operations may start as late as October 2015.

If SWPF starts up in May 2013, SRR estimated that 2 fewer tanks could be closed by the end of the contract in 2017 than originally estimated. If

[13]GAO-08-1081.

[14]As we reported in 2008, the delays are the result of, among other things, additional design that was necessary to meet recommendations from the Defense Nuclear Facilities Safety Board that facilities' designs be robust enough to withstand certain seismic events. The Defense Nuclear Facilities Safety Board was created by Congress in 1988 to provide independent safety oversight at defense nuclear facilities. See 42 U.S.C. §§2286-2286i (2006), and GAO, *Nuclear Material: DOE Needs to Take Action to Reduce Risks Before Processing Additional Nuclear Material at the Savannah River Site's H-Canyon*, GAO-08-840 (Washington, D.C.: July 25, 2008).

SWPF does not begin operations until 2015, SRR estimated a total of 7 fewer tanks would be closed than originally called for in the contract by the contract's end in 2017, or 15 out of the 22 underground tanks originally agreed to in the contract.

In addition, on-time completion of the SWPF may be in question because the facility's construction schedule does not fully meet GAO-identified best scheduling practices. Using industry-standard scheduling practices, we previously identified nine key practices necessary for developing a reliable schedule.[15] These practices are (1) capturing key activities, (2) sequencing key activities, (3) assigning resources to key activities, (4) establishing the duration of key activities, (5) integrating key activities horizontally and vertically, (6) establishing the critical path for key activities, (7) identifying float time—the time that activities can slip before the delay affects the completion date, (8) performing a risk analysis of the schedule, and (9) updating the schedule using logic and durations to determine dates.[16] We initially assessed SWPF's construction schedule in March 2010 and found that it did not fully adhere to these best practices. We discussed these findings with DOE and Parsons officials, and DOE made changes to the schedule. Subsequently, we reassessed the schedule in May 2010 and found that SWPF project officials had taken steps to address some of the problems identified in our initial review but that the schedule still had some shortcomings. Specifically, both of our assessments found that the schedule had problems with excess float time between activities. Float that exceeds a year is unrealistic and should be minimized because excess float times usually indicate that the schedule's activities are not sequenced logically, which reduces confidence that the schedule will be able to meet its completion date. Our March 2010 review found that the schedule had 272 activities with more than 500 days of float time and that two construction activities involving fabrication of piping—usually critical in construction projects—had more than 1,000 days of float time. Our May 2010 assessment found that this problem had become worse, with 433 activities having more than 500 days of float time—an increase of 59 percent. Twenty-two of these activities had more than 1,250 days of float time. Table 1 summarizes the results of our March and May 2010 schedule assessments and appendix II discusses the best practices and our assessments in detail.

[15]GAO-09-3SP.

[16]DOE's guidance on establishing performance baselines includes many of these best practices.

Table 1: SWPF Construction Schedule's Progress in Meeting GAO-Identified Best Practices for Scheduling

Best practice	March 2010	May 2010
Capturing all activities	Fully meets	Fully meets
Sequencing activities	Partially meets	Partially meets
Assigning resources to activities	Fully meets	Fully meets
Establishing the duration of activities	Partially meets	Partially meets
Integrating schedule activities horizontally and vertically	Partially meets	Partially meets
Establishing the critical path for activities	Partially meets	Fully meets
Identifying float between activities	Does not meet	Does not meet
Conducting a schedule risk analysis	Minimally meets	Partially meets
Updating the schedule using logic and durations to determine dates	Partially meets	Partially meets

Source: GAO analysis of DOE's SWPF construction schedule as of March 2010 and May 2010.

DOE is exploring ways of mitigating the effects of SWPF delays. For example, although it was originally planned to operate only until 2011, DOE plans to extend the operations of ARP/MCU—one of the interim processes DOE is using to treat salt waste prior to SWPF operation. In addition, DOE is in the early stages of developing new technologies that will allow it to treat additional quantities of salt waste beyond what is treated by ARP/MCU and SWPF; however, department officials told us that these initiatives will likely not be ready for deployment until 2013. Specifically, DOE is conducting research and development on two technologies—called rotary microfiltration and small-column ion exchange—that will treat salt waste directly in the tank, rather than pumping the waste to a separate facility like ARP/MCU or SWPF.[17] DOE estimates that developing and deploying these two technologies will cost $130 million. DOE officials are hopeful that successful deployment of these new technologies will allow SRR to close all 22 tanks in the December 2008 contract by 2017, as agreed. Moreover, a DOE official said that these technologies could allow closure of the remaining 27 tanks that have secondary containment by 2024—4 years earlier than the 2028 goal committed to by DOE. However, DOE faces hurdles to accomplishing

[17]Rotary microfiltration, which isolates and removes sludge waste, and small-column ion exchange, which isolates and removes high radioactivity salt waste, will yield a low-volume, high-radioactivity salt waste stream for vitrification at DWPF and a high-volume, low-radioactivity salt waste stream suitable for disposal at the Savannah River Site's Saltstone Facility.

these goals using the new technologies. For example, DOE officials told us that, although these technologies are proven, they have never been used to treat liquid radioactive waste at the Savannah River Site and that additional research and development were necessary.

DOE Has Identified Several Challenges to Successfully Closing the Savannah River Site's Underground Waste Tanks

DOE officials with whom we spoke identified three primary challenges to closing the liquid radioactive waste tanks at the Savannah River Site—on-time construction and successful operation of SWPF, increasing the amount and speed at which high-level radioactive waste is vitrified at DWPF, and successfully implementing an enhanced chemical cleaning process for the underground tanks. Although these officials also identified steps the department is taking to ensure these challenges are met, several factors raise concerns about whether DOE will be able to resolve them. Moreover, although most experts we spoke with were generally confident of DOE's ability to successfully overcome these challenges, some of them identified additional concerns about DOE's ability to successfully close the underground tanks.

DOE Is Taking Steps to Overcome the Primary Challenges That Could Impede Savannah River Site Tank Closure, but Concerns Remain About Its Ability to Resolve Them

According to DOE officials, there are three primary challenges to successfully closing the liquid radioactive waste tanks at the Savannah River Site: (1) on-time construction and successful operation of SWPF; (2) increasing the amount and speed at which high-level radioactive waste is vitrified at DWPF; and (3) successfully implementing an enhanced chemical cleaning process for the underground tanks.

- *On-time construction and successful operation of SWPF.* As discussed previously, successful construction of SWPF is vital to DOE's efforts to empty, clean, and permanently close the site's underground tanks because salt waste makes up more than 90 percent of the waste in the tanks. However, in addition to the construction delays that have already occurred and the potential for additional delays in the future, which was discussed earlier, concerns have been raised about SWPF's ability, once constructed, to process waste at a high-enough rate to meet tank closure goals. Specifically, a review by DOE's Office of Cost Analysis that was conducted between September and November 2008 found that ARP/MCU—which is a small-scale version of SWPF and uses essentially the same technology—had only achieved 50 percent of its designed processing rate after about 5 months of operation. The review raised concerns that officials responsible for SWPF may not have planned to fully utilize lessons learned from ARP/MCU operations in the design for SWPF. Because of this, the review found that DOE may be missing opportunities to mitigate SWPF

operational risks. However, DOE officials told us that it was not unusual that ARP/MCU had only achieved 50 percent of its processing rate after only 5 months of operation. These officials said that, because the technology represented a first-of-a-kind nuclear operation, they operated ARP/MCU at a deliberately slow pace during startup. Operating ARP/MCU more slowly also allowed them to collect additional information to inform future operations. According to these officials, ARP/MCU may achieve its optimal processing capacity of 2 million gallons of salt waste per year in fiscal year 2011—3 years after beginning operations—and that lessons learned from the ARP/MCU project are being used in SWPF design. DOE officials said that they hope the more than 2 years of contingency time in the SWPF construction schedule will give them time to ensure the facility will operate as planned. In addition, DOE officials told us that they are working to ensure SWPF is properly integrated with other Savannah River Site radioactive waste storage and treatment facilities to reduce the time needed to ramp up to full operational levels once construction is completed.

- *Increasing DWPF throughput.* As discussed earlier, DWPF produces large metal canisters filled with vitrified high-radioactivity sludge waste that are currently stored at the Savannah River Site pending the availability of a geologic repository for permanent disposal. To meet the December 2008 contract's accelerated schedule for emptying, cleaning, and closing the 22 underground tanks by 2017, SRR must increase production at DWPF from approximately 215 canisters annually to about 400 canisters annually—roughly doubling historical production. In addition, SRR plans to increase the concentration of radioactive waste in each canister. To achieve these improvements, SRR plans to install additional equipment and improve the performance of the melter technology that vitrifies the waste. Although DOE and SRR officials told us that they have confidence in each of the individual improvements planned for DWPF, they are less certain whether the improvements as a group will increase overall DWPF performance. In addition, DWPF has not, to date, ever achieved the levels of efficiency and production that DOE and SRR officials have said will be necessary to achieve tank closure goals. For example, although parts of the system were designed to produce more than 400 canisters per year, DWPF has only achieved an average of about 215 canisters per year throughout its 10 years of operations.

- *Enhanced chemical cleaning.* SRR is relying on a new chemical cleaning process to accelerate tank cleaning with minimal creation of additional waste that must be treated. The current chemical cleaning process to remove residual waste adds oxalic acid with large volumes of water to the tanks. The tank contents are then agitated by mixers that cause the oxalic

acid to bind with the waste, and the mixture is then pumped from the tanks to be prepared for vitrification at DWPF. However, the existing process produces large amounts of radioactive water as a byproduct that must be stored in the Savannah River Site tanks and, eventually, treated. In addition, the oxalate in the acid can negatively affect the vitrification process at DWPF. According to SRR, enhanced chemical cleaning is an improvement on the existing process to remove residual waste because the cleaning solution is recirculated and does not increase the volume of waste in the tanks. In addition, enhanced chemical cleaning eliminates oxalates, reducing the impact on DWPF. DOE and SRR officials told us that enhanced chemical cleaning is the cornerstone of their ability to close tanks on schedule and that there will be cascading negative effects on the entire liquid waste system and the rate at which tanks can be closed if the process does not work as planned. To address the challenge of successfully implementing the enhanced chemical cleaning process, DOE and SRR officials told us that the process will be phased into operation. However, this new process is, to date, unproven for use in liquid radioactive waste tanks. In addition, notwithstanding the importance of enhanced chemical cleaning to successful tank closure, DOE did not provide sufficient funding to continue research and development on the process until December 2009, and SRR officials told us that research efforts have been limited due to this lack of funding. As a result, deployment of enhanced chemical cleaning has been delayed from its original January 2011 planned date until sometime in 2013.

Experts Were Generally Confident in DOE's Ability to Overcome These Challenges, but Many Expressed Additional Concerns

Nearly all of the experts with whom we spoke agreed that the three challenges DOE officials identified to closing the underground tanks at the Savannah River Site—on-time construction and successful operation of SWPF, increasing the amount and speed at which high-level radioactive waste is vitrified at DWPF, and successfully implementing an enhanced chemical cleaning process—are, in fact, the primary challenges the department faces. Many of these experts stated that they were generally confident of DOE's ability to overcome these challenges. Those who did not express such confidence told us that, in their view, they lacked sufficient knowledge of the specific conditions DOE faces at the Savannah River Site to assess whether DOE was capable of overcoming these challenges.

More than half of the experts we spoke with expressed additional concerns. For example, some of the experts we interviewed told us that they believed that DOE may not be sufficiently considering alternative tank cleaning or waste processing technologies. Three experts expressed concern that DOE was disproportionately relying on enhanced chemical

cleaning technologies when, in their view, additional mechanical cleaning technologies may be necessary as well. In addition, one expert recalled a previous situation where DOE relied too heavily on one waste processing technology—called In-Tank Precipitation—to treat waste in the underground tanks. As we reported in 1999, DOE determined the technology would not work as planned after nearly a decade of delays and spending nearly $500 million.[18] Other experts expressed concern that DOE does not have adequate knowledge of the specific characteristics and chemistry of the waste in the tanks. According to these experts, having complete knowledge of the exact characteristics of the waste is important to successfully processing it.

In response, DOE officials told us they believe the department is sufficiently considering alternative waste processing technologies, as evidenced by their continued research and development on the rotary microfiltration and small-column ion exchange technologies discussed earlier. In addition, regarding their knowledge of the characteristics of the waste in the tanks, DOE officials told us that it is always possible that there are unknown chemicals in the tanks. However, because of the extensive historic and current sampling of the waste in the tanks, DOE officials expressed confidence in their knowledge of the characteristics and chemistry of the tank waste.

Conclusions

The potential for significant cost increases and the possibility of accomplishing one-third fewer tank closures by 2017 than agreed to under the December 2008 contract between DOE and SRR raises concerns about the department's ability to successfully close the 22 underground liquid radioactive waste tanks that lack secondary containment at the Savannah River Site within DOE's cost and schedule goals. This concern is based in part on DOE's inability to produce high-quality cost estimates, an issue we have addressed since 2007 in several reports that contained numerous recommendations. In addition, DOE's difficulties planning for and mitigating risks in the Savannah River Site's tank closure project appear to be a continuation of the department's history of difficulties in contract and project management, as well as the findings of its own root cause analysis of this issue. DOE took nearly 6 months to respond to SRR's initial report of a $1.4 billion cost increase in June 2009, and SRR had been operating at

[18]GAO, *Nuclear Waste: Process to Remove Radioactive Waste From Savannah River Tanks Fails to Work*, GAO/RCED-99-69 (Washington, D.C.: Apr. 30, 1999).

the Savannah River Site for more than a year by the time the cost estimates were finalized and a contract performance baseline was approved in August 2010.

We recognize that much of the potential cost increase is the result of pension plan losses due to economic conditions beyond DOE's control, and that the department is obligated to pay those benefits under the terms of its contracts. However, DOE lacked adequate guidance to ensure that the contract signed in December 2008—nearly a year and a half after the onset of the economic conditions that led to those losses—accurately reflected increased pension funding requirements. The department also lacked adequate guidance to ensure that the contract included known costs such as labor, fringe benefits, retiree health care, and essential site services costs incurred under the tank closure contract, rather than other contracts DOE manages at the Savannah River Site. In addition, DOE failed to inform SRR about existing guidance regarding how a contractor can request contract cost increases. Moreover, the exemption of the tank closure project from the requirements of DOE Order 413.3A means that the specific policies and procedures DOE will use to oversee the implementation of the tank closure contract and other Office of Environmental Management operations activities are also uncertain. Without certainty as to the policies and procedures that apply, there is no clear approach for management oversight of tank closure at the Savannah River Site, as well as other DOE operations activities.

The challenges DOE faces to successfully remove highly radioactive liquid waste from the Savannah River Site's underground tanks and to then treat the waste and permanently close those tanks are daunting, but experts we spoke with generally agreed that DOE is potentially up to the challenge. However, we share the experts' concerns that DOE has not engaged in sufficient planning in the event that the department's chosen waste removal, treatment, and tank closure strategies are unsuccessful. For example, on-time completion of SWPF and its successful operation are vital to DOE's tank closure plans. Although DOE has made some improvements to the SWPF construction schedule, several shortcomings remain that need to be corrected for it to comply with GAO-identified best practices and DOE's schedule development guidance. Furthermore, it is important to note that construction delays have already occurred and SRR already estimates that between 2 and 7 fewer tanks than originally planned will be closed by 2017. DOE is in the early stages of planning technologies to mitigate these delays, but it will be several years before these technologies are ready. As a result, we are uncertain whether DOE and

SRR will be able to overcome SWPF construction delays soon enough to achieve the contract tank closure goals.

Recommendations for Executive Action

In light of continuing uncertainty about the costs and schedule to close underground tanks at the Savannah River Site, we recommend that the Secretary of Energy take the following five actions:

- Revise department contract management guidance to ensure it includes provisions that detail how contract cost increases should be requested by a contractor and the specific process DOE should undertake to review and approve the increases, along with a timetable for such a review to take place.
- Revise department contract management guidance to ensure it includes a detailed process by which contract performance baselines are to be reviewed and approved, including appropriate milestones to help ensure that review and approval occur in a timely manner.
- In the absence of the requirements of Order 413.3A, specify policies and procedures that DOE will use to oversee Office of Environmental Management activities that have been exempted from Order 413.3A, including Savannah River Site tank closure activities.
- Develop guidance for DOE contracting officers to ensure that known costs incurred by contractors, such as retiree health care and essential site services, are assigned to the proper contract for sites whose operations are divided into multiple contracts.
- Direct the contractor for the construction of SWPF to revise its construction schedule to ensure conformance with DOE's schedule development guidance and scheduling best practices found in GAO's *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for its review and comment. In its written comments, DOE agreed with our recommendation that specific policies and procedures are needed to oversee Office of Environmental Management activities that have been exempted from Order 413.3A. DOE partially agreed with our recommendation that department guidance should be revised to ensure it includes a detailed process by which contract performance baselines are to be reviewed and approved,

including milestones to help ensure that review and approval occur in a timely manner. However, DOE disagreed with our recommendation to revise DOE contract management guidance to ensure it includes provisions that detail how contract cost increases should be requested by a contractor. In addition, the department disagreed with our recommendation to develop guidance for contracting officers to ensure that known costs incurred by contractors are assigned to the proper contract. Finally, DOE disagreed with our recommendation that the department direct the contractor for the construction of SWPF to revise its construction schedule to ensure conformance with scheduling best practices.

Overall, DOE commented that it had significant concerns with the manner in which we framed our discussion and presented our findings. Specifically, DOE stated that our focus on cost and schedule increases associated with the tank closure contract did not take into consideration the cost and schedule improvements the contract represents over the department's prior tank closure strategy. We disagree. Our draft report noted that the December 2008 contract represented an accelerated schedule of emptying, cleaning, and closing the 22 tanks without secondary containment 5 years sooner than the date in the agreement between DOE, EPA, and South Carolina. Nevertheless, the contract performance baseline that was approved in August 2010 contained a 44 percent increase greater than the cost in the contract. In addition, as our draft report noted, between 2 and 7 fewer tanks may be closed by 2017 than originally called for in the contract. In our view, it is not unreasonable to expect contracts entered into by DOE, or indeed any federal agency, to accurately reflect the costs and schedule to accomplish the goals outlined in the contract. In this case, however, DOE's contractor identified a $1.4 billion cost increase before performing any work under the contract, DOE ultimately approved a contract performance baseline that contained a $1.4 billion cost increase, and the department took more than a year to approve the baseline once the contractor began work. Even though more than $600 million of this cost increase is due to pension cost increases caused by economic conditions outside of DOE's control, we believe DOE's failure to ensure the December 2008 contract accurately reflected increased costs and DOE's delays approving a contract performance baseline are examples of continued contract mismanagement by the department.

DOE agreed with our recommendation that specific policies and procedures are needed for operating activities, including Savannah River Site tank closure activities. DOE commented that a framework for managing and reporting progress for operating activities has been

established, and DOE's sites have been directed that the project management principles contained in DOE Order 413.3A will still apply in a tailored manner. In addition, DOE partially agreed with our recommendation that department guidance should be revised to ensure it includes a detailed process by which contract performance baselines are to be reviewed and approved and include milestones to help ensure that review and approval occur in a timely manner. Specifically, DOE stated that while the department agrees that a timeline is needed to add discipline and rigor to the process for review and approval of contract performance baselines, it already has a rigorous and detailed process established under DOE Order 413.3A. However, as our draft report noted, DOE has exempted many tank closure activities at the Savannah River Site from the full requirements of DOE Order 413.3A. DOE stated that it will expedite the issuance of guidance for contract performance baseline review for operating activities exempted from DOE Order 413.3A.

With regard to our recommendation that DOE revise its contract management guidance to ensure it includes provisions that detail how contract cost increases should be requested by contractors and the specific process DOE should undertake to review and approve the increases, DOE commented that such guidance would be inappropriate to include in departmental policy and redundant to contract clauses required by Federal Acquisition Regulations. While we acknowledge that the contract incorporates certain Federal Acquisition Regulations-mandated contract clauses on this subject, we continue to believe departmental contract management guidance should be revised to ensure it includes provisions that detail how contract cost increases should be requested by a contractor. For example, the contract clause titled "Notification of Changes," which was incorporated by reference into the contract, says that changes must be requested in writing, but does not specify procedures for submitting the written request. As we noted in the report, the department already has guidance that states that a contractor should not be allowed to change estimated contract costs by simply including a higher cost in the contract performance baseline, but the guidance was not followed by either SRR or DOE. In addition, the guidance mentioned by DOE in its comments that established a 180-day contract administrative lead time requirement for resolving contract change requests does not provide information as to how contractors are to submit changes in order to trigger the 180-day review period. Moreover, DOE noted that SRR required additional contract clarification guidance to comply with the contract provisions at issue. Furthermore, SRR officials told us that there was a miscommunication between DOE and SRR regarding the process to

request a contract cost increase. As a result, we continue to believe more clarity in DOE guidance is necessary.

DOE did not agree with our recommendation to develop guidance for contracting officers to ensure that known costs incurred by contractors are assigned to the proper contract. The department noted that the majority of the cost increases we identified in the report are associated with fluctuating indirect costs mainly due to economic conditions beyond either the department's or the contractor's control, and that these cost fluctuations are not related to project performance. As our draft report noted, we agree that a significant amount of the cost increase—more than $600 million in pension costs—is due to economic conditions beyond DOE's control. Nevertheless, DOE had nearly a year and a half after the onset of the economic conditions to ensure that the contract accurately reflected increased pension costs. We have also modified our draft report to acknowledge that the $270 million contract cost increase associated with retiree health care and essential site services does not represent an increased cost to the taxpayer because these costs would be eliminated from the management and operations contract at the Savannah River Site. However, this $270 million still represents an unplanned increase in the costs associated with the tank closure contract. As discussed previously, we believe contracts entered into by DOE should accurately reflect the costs to accomplish the goals outlined in the contract. Therefore, we maintain that guidance to ensure appropriate allocation of costs between contracts at sites whose operations are divided into multiple contracts is necessary.

Regarding our recommendation that DOE should direct the contractor for the construction of SWPF to revise its construction schedule to ensure conformance with scheduling best practices, the department commented that the contractor has developed and maintains a schedule that exhibits best practices included in industry standards such as GAO's *Cost Estimating and Assessment Guide*. We disagree. As we noted in our draft report, based upon our analysis of the SWPF construction schedule in both March and May 2010, DOE has made some improvements to the SWPF schedule, but shortcomings remain. In particular, both of our assessments found that the schedule had problems with excess float time, which indicates that the schedule's activities are not sequenced logically. DOE believes that having long float times is appropriate for the schedule's current level of maturity. We disagree. In our view, including in the schedule activities that could slip by up to 3 years and not impact the project's overall end date is not realistic and does not meet scheduling best practices. However, we are encouraged that DOE and the contractor

will continuously assess the schedule against best practices to ensure that float time is appropriately managed.

DOE also provided technical comments that we incorporated in the report as appropriate. DOE's written comments are presented in appendix III.

We are sending copies of this report to the appropriate congressional committees; the Secretary of Energy; the Director, Office of Management and Budget; and other interested parties. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or trimbled@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix IV.

David C. Trimble
Acting Director, Natural Resources
and Environment

Appendix I: Scope and Methodology

To determine the current costs and schedule for closing the tanks at the Savannah River Site and the extent to which the Department of Energy (DOE) established these using best practices, we analyzed cost and schedule documents such as DOE's June 2007 tank closure cost estimate, the December 2008 tank closure contract between DOE and Savannah River Remediation, LLC (SRR), SRR's contract performance baseline, and tank closure cost increase proposals. To determine the extent to which DOE established tank closure costs using best practices, we compared both the process by which DOE developed these documents, as well as evidence collected through interviews with DOE—at the Savannah River Site and in Washington, D.C.—and SRR officials, to GAO-identified best practices for cost estimating.[1] We also analyzed DOE's contract management plan and interviewed DOE officials responsible for administering the tank closure contract to determine the process the department is employing to review and approve SRR's proposed cost increases, and compared this process to the steps contained in DOE guidance on how proposed contract cost increases should be prepared, reviewed, and approved.

To determine the extent to which DOE established the tank closure schedule using best practices, we reviewed the construction schedule for the Salt Waste Processing Facility (SWPF), a facility that will be used to treat a majority of the tank waste. Specifically, with the assistance of scheduling experts, we evaluated the reliability of the SWPF construction schedule to determine the extent to which it captures key activities, is correctly sequenced, establishes the duration of key activities, is integrated, and has an established reliable critical path, among other things. We conducted an initial assessment in March 2010 and shared the results of this assessment with DOE and contractor officials. We based our assessment on GAO-identified best practices associated with effective schedule estimating,[2] many of which are also identified by DOE in its guidance on establishing performance baselines.[3] We then interviewed DOE and contractor officials to obtain information on how the SWPF construction schedule is developed and maintained. We then conducted a second assessment in May 2010 to evaluate the extent to which the

[1]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

[2]GAO-09-3SP.

[3]DOE, *Performance Baseline Guide*, DOE G 413.3-5 (Washington, D.C., 2008).

schedule improved in its adherence to GAO-identified best scheduling practices.

To determine the primary challenges DOE faces to close the Savannah River Site's liquid radioactive waste tanks and the steps the department has taken to address them, we interviewed DOE officials and asked them to identify the primary challenges the department faces and the steps DOE has taken to address them. We also reviewed past and current tank closure plans and risk management documents, toured Savannah River Site facilities relevant to tank closure, and attended DOE and SRR briefings on components of the Savannah River Site's liquid radioactive waste system and the proposed modifications to the system to gain an understanding of these challenges and how DOE planned to address them. To corroborate that DOE had identified the primary challenges to tank closure, we interviewed 11 experts—all of whom have extensive knowledge of tank closure-related activities—and solicited their views on the primary tank closure challenges. We identified these experts in consultation with various sources including the National Academy of Sciences and the South Carolina Governor's Nuclear Advisory Council, and using GAO's prior work on tank closure activities at DOE's Hanford Site in Washington State.[4] We then contacted these individuals and asked for additional referrals. We continued this iterative process until additional interviews did not lead us to any new names or we determined that the qualified experts in this field had been exhausted. We then asked these individuals questions to determine the nature and extent of their expertise, and to ensure that they were not currently or recently employed by DOE or SRR. The final list of experts included primarily university professors and consultants. We developed a semistructured interview guide, containing both closed- and open-ended questions, to solicit responses about the primary challenges DOE identified to close the Savannah River Site's tanks and the steps DOE proposed to address the identified challenges. Using the guide, we interviewed each expert by telephone. Because some of the questions were open-ended, and experts were knowledgeable about varied—but not all—aspects of the issues covered, we did not attempt to quantify their responses to these questions for reporting purposes. In addition, we interviewed multiple entities that are stakeholders in the tank closure process, including the U.S. Nuclear Regulatory Commission, the

[4]GAO, *Nuclear Waste: Uncertainties and Questions about Costs and Risks Persist with DOE's Tank Waste Cleanup Strategy at Hanford*, GAO-09-913 (Washington, D.C.: Sept. 30, 2009).

Environmental Protection Agency, the Defense Nuclear Facilities Safety Board, and the South Carolina Department of Health and Environmental Control, to obtain their views on the challenges DOE faces to close the Savannah River Site's tanks and the steps the department is taking to address these challenges.

We conducted this performance audit from June 2009 to September 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: GAO Assessment of DOE's SWPF Construction Schedule

Practice	Explanation	GAO's March 2010 assessment	GAO's May 2010 assessment
Capturing all activities	The schedule should reflect all activities as defined in the program's work breakdown structure, including activities to be performed by both the government and its contractors.	Practice fully met: The schedule lists activities in a careful and complete manner using consistent language. Also, the schedule contains a wide scope of activities, such as activities related to design, procurement, fabrication, and installation. The schedule is comprised of 9,177 activities.	Practice fully met: No change from previous assessment. See "GAO's March 2010 assessment" column for details. The schedule now has 11,291 activities, an increase of 23 percent.

Practice	Explanation	GAO's March 2010 assessment	GAO's May 2010 assessment
Sequencing all activities	The schedule should be planned so that it can meet critical program dates. To meet this objective, activities need to be logically sequenced in the order in which they are to be carried out. In particular, activities that must finish prior to the start of other activities (i.e., predecessor activities), as well as activities that cannot begin until other activities are completed (i.e., successor activities), should be identified. By doing so, interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. The schedule should avoid logic overrides and artificial constraint dates that are chosen to create a certain result.	Practice partially met: The dates of milestones and activities are mostly determined by the durations and predecessor-successor logic. However, we identified multiple problems with the schedule's logic, use of constraints, and use of lags that keep the schedule from meeting this best practice. The schedule contains multiple instances of incomplete logic, also called open ends, in which predecessor and successor activities are not properly linked. For example, we found 450 instances of incomplete logic of which 409 were instances where activities were not linked to predecessor activities; this fact leads to reduced confidence in the schedule's ability to meet its completion date. In addition, the schedule makes excessive use of constraints, which are used instead of logically-linked predecessor activities to start activities. We identified 831 activities that are constrained to start as late as possible—meaning that even if the activity's duration takes one day longer than estimated, its successor activity will be delayed. According to best scheduling practices, the schedule should use logic and durations to reflect realistic start and completion dates for project activities. The schedule also makes extensive use of lags, which are the duration between activities that delay successor activities. Lags should be used to represent fixed, physical gaps between activities such as the time needed for concrete to cure. The lags used in the schedule are both too many in number and too long in duration to represent the physical gaps. Specifically, we found 60 instances where the lag was more than 100 days in duration.	Practice partially met: The schedule still has a number of instances with incomplete logic and constraints. The schedule now contains more instances of incomplete logic than the one we assessed in March. Specifically, there are now 539 instances of incomplete logic, which is an increase of almost 20 percent. The schedule's use of constraints has been reduced, but not eliminated. Specifically, we found that the number of constrained tasks decreased from more than 800 to 158. The schedule now contains 101 activities with lags more than 100 days. This is an increase of 68 percent.

Practice	Explanation	GAO's March 2010 assessment	GAO's May 2010 assessment
Assigning resources to all activities	The schedule should reflect what resources (e.g., labor, material, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist.	Practice fully met: The schedule contains multiple resources and their application to various activities was carefully done. The schedule contains the project's total cost.	Practice fully met: No change from previous assessment. See "GAO's March 2010 assessment" column for details.
Establishing the duration of all activities	The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. In particular, durations of longer than 200 days should be minimized.	Practice partially met: The schedule contains a significant number of activities with long durations, especially when the durations are compared to the remaining duration of the entire project. We found 627 activities whose duration is greater than 5 percent of the schedule's total remaining duration. Any activities with durations of greater than 5 percent of the schedule's total remaining duration should be examined closely to see if it is possible to schedule the activities in smaller increments to improve the management of those activities.	Practice partially met: The schedule continues to contain many items with long durations that appear as if they could be shortened. We identified 827 activities whose duration is greater than 5 percent of the schedule's total remaining duration. This is an increase of 32 percent, a greater increase than the overall number of activities increased.
Integrating activities horizontally and vertically	The schedule should be horizontally integrated, meaning that it should link the products and outcomes associated with other sequenced activities. These links are commonly referred to as handoffs and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that traceability exists among varying levels of activities and supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule.	Practice partially met: The schedule is partially horizontally integrated. This is the result of the problems identified in the "sequencing all activities" practice related to incomplete logic, as well as the use of constraints and lags. The schedule is vertically integrated as it includes filters that allow summary or milestone schedules to be developed from the master schedule.	Practice partially met: The schedule is partially horizontally integrated due to the continued instances of incomplete logic and the use of constraints. The schedule continues to be vertically integrated.

Practice	Explanation	GAO's March 2010 assessment	GAO's May 2010 assessment
Establishing the critical path for all activities	Using scheduling software, the critical path—the longest duration path through the sequenced list of key activities—should be identified. The establishment of a program's critical path is necessary for examining the effects of any activity slipping along this path. Potential problems that might occur along or near the critical path should also be identified and reflected in the scheduling of the time for high-risk activities.	Practice partially met: The schedule contains a distinct critical path, but we identified problems with it. Specifically, the critical path's initial activity has an excessively long duration, which makes it difficult to accurately measure the progress being made to complete the activity. Further, there is one instance of incomplete logic on the critical path.	Practice fully met: The schedule contains a distinct critical path, and it is different from the one presented in March 2010. We identified no problems with the revised critical path.
Identifying the "float time" between activities	The schedule should identify float time—the time that a predecessor activity can slip before the delay affects successor activities—so that schedule flexibility can be determined. As a general rule, activities along the critical path typically have the least amount of float time. Total float time is the amount of time flexibility an activity has that will not delay the project's completion (if everything else goes according to plan). Total float that exceeds a year is unrealistic and should be minimized.	Practice not met: The schedule contains an excessive amount of activities with too much float, which indicates that activities are not linked using logic. Specifically, the schedule contains 272 activities with more than 500 days of float and two construction activities involving fabrication of piping—usually critical in construction projects—that had more than 1,000 days of float time and neither activity was linked to a successor activity.	Practice not met: The schedule continues to have several activities with excessive amounts of float. We identified more than 433 activities with more than 500 days of float. This is an increase of 59 percent, a greater increase than can be explained by the overall increase in activities. There are 22 activities with more than 1,250 days of float. As such, the department is unable to realistically determine how much an activity can slip before it impacts the end date. In this case, those activities could slip by up to 3 years and not impact the overall end date.

Practice	Explanation	GAO's March 2010 assessment	GAO's May 2010 assessment
Performing a schedule risk analysis	A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a program's completion date. This analysis focuses not only on critical path activities, but also on activities near the critical path, since they can potentially affect program status.	Practice minimally met: The schedule contains reserve time—a buffer for the schedule baseline—but there is no evidence that this reserve time was based on a risk analysis using data about project schedule risk or statistical techniques, as required by best practices.	Practice partially met: Reserve time was established largely using empirical methods, but the methods lacked the use of a rigorous statistical technique required by best practices. DOE and contractor officials presented evidence that they conducted a schedule risk analysis based on data about the project schedule risk, specifically a risk management plan. However, DOE used a less rigorous statistical technique than the one specified in best practices. Specifically, DOE's statistical technique does not fully account for potential changes to the order in which activities are sequenced. Given that our May 2010 assessment found continued problems with how activities are sequenced—the schedule remained only partially compliant with this best practice—the potential for changes to the order in which activities occur is possible. It is unclear if DOE's current schedule risk analysis would remain valid should these potential changes materialize.
Updating the schedule using logic and durations to determine dates	The schedule should be continually monitored to determine when forecasted completion dates differ from the planned dates, which can be used to determine whether schedule variances will affect downstream work. Individuals trained in critical path method scheduling should be responsible for ensuring that the schedule is properly updated. Maintaining the integrity of the schedule logic is not only necessary to reflect true status, but is also required before conducting a schedule risk analysis.	Practice partially met: The techniques used to measure progress on the schedule, such as containing current budget information, is consistent with standard scheduling best practices, but the multiple instances of incomplete logic mean the schedule partially meets best practices. A schedule must have all its activities logically sequenced in the order that they are to be carried out to provide reasonable and accurate forecasts.	Practice partially met: Discussions with DOE's scheduler indicated that the schedule is updated monthly, in accordance with best practices, but continued instances of incomplete logic call into question the schedule's overall accuracy.

Source: GAO assessment of DOE's SWPF schedule based on GAO-identified best scheduling practices.

Notes: The ratings we used in this analysis are as follows: Based on the documentation provided, "fully" means that the project fully satisfied the practice; "mostly" means that the project satisfied the practice to a large extent; "partially" means that the project satisfied the practice in part; "minimally" means that the project satisfied the practice to a minimal extent; and "not" means that the project did not satisfy the practice.

During our initial assessment of the SWPF construction schedule in March 2010, we inadvertently incorporated activities unrelated to SWPF into the assessment, which produced inaccurate statistics. To correct this, we obtained a new copy of the SWPF schedule and DOE officials agreed that the general conclusions of our March 2010 assessment are still considered valid.

Appendix III: Comments from the Department of Energy

Department of Energy
Washington, DC 20585

August 20, 2010

Mr. David C. Trimble
Acting Director of Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Trimble:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the Government Accountability Office (GAO) Draft Report, "NUCLEAR WASTE – Actions Needed to Address Persistent Concerns with Efforts to Close Underground Radioactive Waste Tanks at DOE's Savannah River Site," GAO-10-816. We acknowledge that GAO invested the time and resources to gain a better understanding of the status of the Liquid Waste Program and tank closure activities at the Savannah River Site (SRS) and the actions taken and planned by the Department to successfully execute SRS's tank waste strategy.

While the Department agrees or partially agrees with two of the five recommendations, it disagrees with the remaining three recommendations. The Department also has significant concerns with the manner in which GAO has framed its overall discussion and presentation of its findings. Specifically, GAO focused exclusively on cost and schedule increases associated with the contract award value without taking into consideration overall life-cycle management of the tank waste program. At no time did the Department change its approved Federal Baseline; the contract cost adjustments identified as increases do not exceed the cost profile in the Federal Baseline. Moreover, the new contracting strategy has resulted in substantial acceleration in mission execution.

The Department's Acquisition Strategy at SRS is based on the need to separate management and operating type activities focusing on ongoing operations and lower risk cleanup, such as soil and groundwater and solid waste disposition from the highest risk and most costly work related to site tank waste disposition. This approach allows a new contractor to focus exclusively on optimizing tank operations to accelerate retrieval and closure of tanks. The Department determined that this work would best be executed under a stronger Federal Acquisition Regulation (FAR) Part 15 contract vehicle with incentives for better management of performance within cost and schedule.

The contract awardee, Savannah River Remediation LLC (SRR), proposed to close 22 old-style tanks within the 8-year contract performance period. The contract award price

was impacted by contract adjustments necessary to accurately reflect increases for indirect costs, such as pensions, that resulted in two fewer tanks being projected to be closed. Nowhere in the report does GAO acknowledge the substantial improvement of the SRR contract over the Department's Federal Baseline which reflects closure of only 12 tanks over the same time period. Therefore, the Department is making good on its commitment, through the successful implementation of its Acquisition Strategy, to accelerate the Liquid Waste Program over the approved Federal Baseline by as much as two-thirds.

Further, GAO acknowledges that we are exploring additional ways to mitigate any schedule delays by introduction of new technologies. The Department has initiated contract modifications to implement these mitigating technologies, including rotary microfiltration, small column ion exchange, and accelerating treatment of Tank 48 waste with steam reforming. The Department expects SRR's contract cost proposal in September 2010 and plans to definitize this contract action in the Fall 2010. Implementation of these technologies will further accelerate tank retrievals to regain the full 22 tank closures proposed by SRR and result in life-cycle savings of over $3 billion by completing the tank waste disposition mission six years earlier than currently planned. An updated Federal Baseline is being prepared for approval in September 2010 to reflect these savings.

Finally, the Department does not agree with GAO's critique of the schedule for the Salt Waste Processing Facility Project (SWPF). The Department believes that the contractor for SWPF now has developed and is maintaining a schedule that exhibits best practices included in industry standards such as the Project Management Institute's Project Management Body of Knowledge Guide. In addition, the recent SWPF contract modification signed by DOE and Parsons on August 14, 2010, places greater incentives on schedule acceleration and increased processing capacity. These improved SWPF contract incentives in combination with implementation of the tank waste treatment technologies described above will mitigate any schedule delays and ensure a more efficient execution of the tank waste cleanup.

DOE's responses to the recommendations are presented below.

Revise Department contract management guidance to ensure it includes:

Provisions that detail how contract cost increases should be requested by a contractor and the specific process DOE should undertake to review and approve the increases, along with a timetable for such review to take place.

Such guidance for contractor use would be inappropriate to include in Departmental policy and redundant to the FAR-prescribed contract clauses which already impose such procedures on a contractor by placing them in their contract. The inclusion of several key provisions that give specific instructions to both the contractor and the contracting officer regarding the treatment of proposed increases to contract cost estimates was accomplished at the onset of this acquisition.

In 2008, the Office of Environmental Management (EM) issued guidance that established a 180-day contract administrative lead time requirement for resolving contract change requests once they are formally and properly submitted by the contractor in accordance with the terms and conditions of the contract. In SRR's case, following additional DOE contract clarification guidance, the contractor complied with the contract requirements (changes clause) on February 5 and 9, 2010, the contracting officer took prompt action to modify the contract to accommodate the increased in scope cost estimates within the 180-day timeframe established by EM policy for definitizing contract changes.

Although we disagree that guidance for the contractor related to contract cost changes should appear in Departmental guidance, EM will make a recommendation to the Secretary of Energy that time tables for resolving contract changes that EM has established in its programmatic contract guidance would be prudent for implementation DOE-wide.

A detailed process by which contract performance baselines are to be reviewed and approved, including appropriate milestones to help ensure that the review and approval process occurs in a timely manner.

DOE partially agrees with this recommendation. DOE already has a rigorous and detailed process established under DOE Order 413.3A, entitled Program and Project Management for the Acquisition of Capital Assets, for review and approval of baselines. Whether it is a contract baseline or a project baseline there is essentially no difference in the documentation needed or the review and approval process. The only element that the contract baseline does not include is the risk based analysis supporting DOE Contingency, and further, this element of DOE Contingency applies only to capital asset projects. The timelines for review and approval of the performance baseline for capital asset projects are governed by readiness of the project's design stage and budgeting process.

For contracts related to Operating Activities the principles of DOE O 413.3A apply. In light of EM's recent split of Capital Projects and Operating Activities to enhance schedule and cost performance, we agree with GAO that a timeline is needed to add discipline and rigor to the process for review and approval of contract performance baselines for Operations Activities. As an improvement action we will expedite the issuance of guidance for contract performance baseline review and approval time table for operating activities.

In the absence of the requirements of Order 413.3A, specify policies and procedures that DOE will use to oversee Office of Environmental Management activities that have been exempted from Order 413.3A, including Savannah River Site tank closure activities.

DOE agrees that specific policies and procedures are needed for operating activities including SRS tank closure activities. To date, a framework for managing and reporting progress for the operating activities and programs has been established and the sites have been directed that the project management principles contained in DOE Order 413.3A will

still apply in a tailored manner. Although Critical Decisions are no longer required, EM expects the sites to maintain control of the operating activities, utilize site-level processes and procedures that are currently in place, manage operations work scope effectively and efficiently, and meet contract, funding and performance requirements. EM is currently in the process of preparing a Standard Operating Policy and Procedure for Managing and Reporting of Operating Activities.

Develop guidance for DOE contracting officers to ensure that known costs, such as retiree health care and essential site services incurred by contractors are assigned to the proper contract for sites whose operations are divided into multiple contracts.

On the matter of the contract cost adjustments identified as cost increases, the majority of the cost increases identified by GAO are associated with fluctuating indirect costs mainly due to economic conditions beyond either the Departments or the contractor's control. These cost fluctuations are not related to mission or project performance, but rather associated with allocation of indirect costs such as pensions and other infrastructure costs. DOE has an adequate process to allocate these indirect costs at the time they are incurred and does not need to develop guidance for its contracting officers.

Over the past four years due to significant fluctuations in pension investment returns, we have twice reprogrammed tens of millions of dollars in order to fund pension shortfalls. Last year, without the significant infusion of Recovery Act funding, we would have had significant mission impacts in order to a meet a pension shortfall of hundreds of millions of dollars.

In fact, during the solicitation phase of this acquisition, all offerors were instructed to include government-provided cost estimates for the defined benefit pension program for evaluation purposes with the full intention of updating the estimates of these non-fee bearing costs following contract award. Such costs were understood to be subject to fluctuation and not within the control of the bidders and, as such, were immaterial to the proposal review. As of August 6, 2010, the contract performance baseline was approved reflecting the latest indirect project costs to the award.

Direct the contractor for the construction of SWPF to revise its construction schedule to ensure conformance with DOE's schedule development guidance and scheduling best practices found in GAO's "Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs".

The Department believes that the contractor for SWPF has developed and maintains a schedule that exhibits best practices included in industry standards such as the Project Management Institute's Project Management Body of Knowledge Guide and GAO's Cost Estimating and Assessment Guide. DOE and the contractor will continuously assess the schedule against these best practices to ensure that activity duration estimating practices such as constraints and Critical Path Analysis results such as float are appropriately managed.

GAO's review identified long float activities and constraints negatively impacting the project schedule. The Department believes that these working-schedules are appropriate for this planning maturity and that the overall schedule will be tightened later as more precise schedule durations are determined. The Department and the contractor will continuously assess the schedule against best practices and GAO's Cost Estimating and Assessment Guide to ensure that activity duration estimating practices, critical path activities and float are appropriately managed.

Again, thank you for your assistance as we continue to strengthen our Liquid Waste program at SRS. We have gained substantial experience over the past decade in the cleanup of tank waste. In addition, over the past several years the Department has continuously improved contract and project management performance to better address the inherent uncertainties of our high risk cleanup program.

We welcome direct dialogue with you on these issues prior to finalizing your report. Should you have questions on the status of the evaluation, please contact me at (202) 586-7709 or Mr. Mark Gilbertson at (202) 586-0755.

Sincerely,

Inés Triay

Inés R. Triay
Assistant Secretary for
Environmental Management

Enclosure

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

David C. Trimble, (202) 512-3841, or trimbled@gao.gov

Staff Acknowledgments

In addition to the individual named above, Ryan T. Coles, Assistant Director; Patrick Bernard; Robert Campbell; Antoinette Capaccio; Kathryn Edelman; Jennifer Echard; Tim Persons; John Smale Jr; and Michelle K. Treistman made key contributions to this report.

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