United States General Accounting Office

GAO

Report to the Committee on Government Reform, House of Representatives

June 2004

NUCLEAR WASTE

Absence of Key Management Reforms on Hanford's Cleanup Project Adds to Challenges of Achieving Cost and Schedule Goals

GAO-04-611

June 2004

NUCLEAR WASTE

Absence of Key Management Reforms on Hanford's Cleanup Project Adds to Challenges of Achieving Cost and Schedule Goals

GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-04-611, a report to the Committee on Government Reform, House of Representatives

Why GAO Did This Study

The Department of Energy's (DOE) Hanford Site in Washington State houses DOE's largest and most complex nuclear cleanup project—treating and preparing for disposal 55 million gallons of high-level radioactive waste. In 2000, DOE awarded an 11-year, $4.3 billion contract to design, construct, and test treatment facilities at Hanford. GAO was asked to review (1) efforts to accelerate the project's completion, (2) implementation on this project of agencywide management reforms, and (3) the challenges resulting from any unimplemented reforms.

What GAO Recommends

GAO recommends that DOE (1) follow more closely its project management guidance when acquiring complex nuclear waste treatment plants, especially by avoiding a fast-track, concurrent design-build approach, and (2) develop and provide to Congress a plan that includes an estimate of the costs and time frames needed to treat and dispose of DOE's high-level tank wastes if most of these wastes must be disposed of in an underground high-level waste repository. In commenting on the report, DOE generally agreed with the recommendations, including improving its cost estimates, but was unwilling to develop an alternative treatment plan for high-level waste until the legal issues are decided. GAO believes that any cost estimate DOE develops should be based on a specific plan.

www.gao.gov/cgi-bin/getrpt?GAO-04-611.

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

What GAO Found

DOE's initial approach called for treating 10 percent of the site's high-level waste by 2018 and for operating the plant until treatment was completed in 2046—well past a regulatory deadline to complete treatment by 2028. In 2002, DOE decided to accelerate cleanup by about 20 years and reduce the project's $56 billion cost by $20 billion. In the short term, however, several factors, including the accelerated approach and contractor performance problems, have lengthened construction time and raised contract costs by $1.4 billion to $5.7 billion.

Because of long-standing problems that preceded Hanford's contract, DOE has instituted reforms in both contract and project management. DOE's 2000 Hanford contract implemented the contract performance reforms, including linking contractor fees to cost and schedule performance. The contract did not, however, implement project management reforms, such as an overall plan to accomplish waste treatment by the regulatory deadline.

Not implementing project management reforms at the outset has added to the risks in cleaning up Hanford's tank waste. First, to start quickly, DOE committed to a "fast-track" process in which design, technology development, and construction are performed concurrently on different aspects of the project. For projects of Hanford's complexity, this approach is not compatible with controlling costs and schedules. Second, DOE has delayed completing analyses needed to determine the most cost-effective approach to waste separation and may have missed savings opportunities of at least $50 million a year. Third, DOE has not adequately defined or communicated the potential effects of a legal challenge to its overall plan for minimizing how much high-level waste is disposed of in an underground repository. Unless effectively managed, an adverse legal outcome could increase project costs by tens of billions of dollars.

High-level Vitrification Plant at Hanford's Waste Treatment Construction Site, March 2004

Source: DOE photo.

Contents

Abbreviations

AEA	Atomic Energy Act of 1954
AEC	Atomic Energy Commission
CHG	CH2M Hill Hanford Group
DOE	Department of Energy
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
NRC	Nuclear Regulatory Commission
OMB	Office of Management and Budget

GAO
Accountability * Integrity * Reliability

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

June 9, 2004

The Honorable Thomas M. Davis
Chairman
The Honorable Henry A. Waxman
Ranking Minority Member
Committee on Government Reform
House of Representatives

The Department of Energy (DOE) spends almost $20 billion a year—about 90 percent of its fiscal year 2003 budget—on contracts, including those for operating its installations. These operations include extensive projects for treating and storing radioactive and hazardous wastes accumulated over more than 50 years of nuclear weapons production—a task DOE has estimated will cost more than $142 billion (fiscal year 2003 dollars) and will not be completed until 2035. DOE's success has been mixed, with some cleanup projects going well but others producing few or no results after the expenditure of hundreds of millions of dollars. We and others have criticized DOE for failing to hold its contractors accountable for results and for inadequate management and oversight of its projects. In response, starting in the mid-1990s, DOE undertook two main reform initiatives—both were designed to improve contractor performance in carrying out major projects. The contract performance initiative, which DOE formalized in 1996, included ensuring that DOE begins projects by using the appropriate contract type, encouraging greater competition in contract bids, and linking contract award fees more closely to contractor performance. The project management initiative, started in 1999 and resulting in new management guidance in 2003, required DOE and its contractors to implement certain management practices, such as following a more disciplined decision-making process for defining, planning, and carrying out major projects.

You asked us to review the impact of these management reform efforts at DOE's largest and most complex cleanup project—the waste treatment

project[1] at DOE's Hanford Site in Washington State. Hanford's waste treatment project involves more than 55 million gallons of radioactive and hazardous waste—enough to fill an area the size of a football field to a depth of more than 150 feet—stored in 177 underground tanks. DOE has managed this waste over the years as high-level waste.[2] The overall project involves two major steps: (1) designing, constructing, and testing a waste treatment plant[3] (the construction project) and (2) operating this plant and others in subsequent years to process and prepare the tank waste for permanent disposal (the operations project). In 2000, after DOE had announced its agencywide contract and project management reforms, it awarded an 11-year, $4.3 billion contract for the construction project. In April 2003—as part of a nationwide effort that DOE started in 2002 to reduce the costs and schedule for cleaning up many of its sites—DOE revised Hanford's waste treatment project, accelerating it to help meet a 2028 deadline that the department had agreed to with Washington State in 1989. Our analysis examines the interaction of these four separate efforts—the contract performance initiative, the project management initiative, DOE efforts to accelerate cleanup at its sites, and the waste treatment project at Hanford. Specifically, this report examines (1) the DOE accelerated approach for addressing Hanford's tank waste, including any changes in the construction project's cost or schedule; (2) the extent to which DOE's contract and project management reforms have been implemented on the construction project; and (3) the challenges resulting from any unimplemented reforms on the potential for completing the waste treatment project successfully.

This report is based on detailed work we conducted at DOE's Hanford Site near Richland, Washington, and on our analysis of cost and schedule information and legal documents pertaining to the waste treatment project. We also reviewed DOE's contract reform and project management initiatives, including our prior reports on those initiatives. To evaluate the

[1]This project is officially known as the River Protection Project. The Columbia River flows through the site, and the cleanup is designed in part to keep contamination from reaching the river. In this report, we refer to the project as the "waste treatment project."

[2]For this report, we use the term "high-level waste" to refer to the waste that DOE is managing as high-level waste. DOE's Hanford Site is one of three DOE sites with high-level wastes needing treatment; the other two are the Savannah River Site in South Carolina and the Idaho National Laboratory.

[3]The waste treatment plant consists of one facility to separate the waste, two facilities to treat separated portions of the waste, and one laboratory and other supporting facilities.

technical aspects of the Hanford waste treatment project, we obtained the assistance of a physicist with extensive experience in the nuclear field. A detailed discussion of our scope and methodology appears in appendix I. We conducted our review from July 2003 through May 2004 in accordance with generally accepted government auditing standards.

Results in Brief

DOE's accelerated waste treatment approach calls for significant changes in treating and disposing of Hanford's tank wastes as a way of saving both time and money when the waste treatment facilities begin operation. Under the approach of its December 2000, $4.3 billion contract with Bechtel National, Inc. (Bechtel National), DOE estimated that cleaning up the waste would cost about $56 billion and take until about 2046. The accelerated approach calls for completing waste treatment by 2028; by reducing cleanup by almost 20 years, DOE estimates it will save about $20 billion. The accelerated approach came about 2 years after the construction contractor, operating under the assumptions of DOE's previous approach, had begun to design, build, and test the waste treatment plant. DOE increased the contract amount for the construction project by $1.4 billion, to $5.7 billion, to reflect the accelerated approach's added production capacity, contractor performance problems, additional design work, and better estimates. DOE also lengthened by 16 months the time for designing and building the plant. To keep the construction project on schedule despite the increase, however, DOE decided to shorten the commissioning phase—the period for testing the plant to ensure that it will work properly once operations begin—by nearly the same amount. As a result, DOE has maintained its schedule to begin operation of the waste treatment plant by 2011.

DOE's 2000 contract implemented the department's contract performance initiative but not its project management initiative. Elements of the contract initiative in place at the contract's start included ensuring that a competitive process for bidding the 2000 contract was followed and paying contractor performance fees on the basis of the cost and time required to successfully complete the plant. Because it was under pressure to meet regulatory milestones and keep the project moving forward, however, DOE awarded the contract without fully implementing its project management initiative, which the department had developed but not yet issued in final form. For example, the initiative calls for developing, at the beginning of a project, an approach that can meet mission requirements. The initial contract DOE awarded, however, called for designing and building a plant that would not be able to complete the cleanup by 2028, the time frame

DOE agreed to with Washington State. Similarly, the project management initiative calls for a project's cost and schedule to be validated before setting a firm project price. At the time of contract award, however, DOE's cost and schedule estimates had not been fully validated to determine if they were realistic. Since 2002, DOE has implemented various steps called for in the project management initiative, such as developing a more realistic baseline and increasing project contingency.

DOE's decision not to implement the project management initiative at the start of the construction project has added to the risk and uncertainty the department faces in completing both the construction and operations projects. The initiative's main purpose is to minimize problems that have plagued DOE in the past by taking such steps as avoiding or mitigating high-risk strategies for constructing facilities, as well as by conducting rigorous analyses to support key decisions. In awarding the 2000 contract without these steps being fully implemented, DOE has adopted a high-risk strategy at Hanford. According to Hanford project officials, implementing project management steps subsequently, as DOE has begun to do under its accelerated approach, is intended to provide a more disciplined method for keeping the project's cost and schedule on track. In our view, however, these steps cannot eliminate the risk and uncertainty resulting from the department's decision not to implement the project management initiative from the start. This risk and uncertainty comes from three main sources:

- *Using a fast-track management approach.* DOE has committed to a "fast-track" process in which many design, technology development, and construction activities are performed simultaneously, thereby significantly increasing the risk of cost increases and schedule delays as the construction project progresses. Performance so far on the construction project has been mixed—problems have already contributed to the $1.4 billion construction cost increase. Furthermore, our review indicates that cost, schedule, and performance problems continue, although they have not yet affected the revised project baseline. For example, construction activities, such as building interior walls, have outpaced design, leading to delays in finishing the walls and the need to temporarily reassign construction workers to other tasks. In addition, efforts to resolve key technical challenges, including incorporating alternative treatment technologies, continue to fall behind and threaten to affect the overall project's baseline. Hanford's construction project manager acknowledged that the contract schedule for building and testing the plant and concurrently resolving technical issues was and still is high risk. Although he and other DOE officials

stated they have taken adequate steps to mitigate this risk, DOE, since contract award, has continued to encounter significant technical and other problems. Given the risk inherent in this project, we and outside experts believe that further cost increases, as well as schedule delays, are likely.

- *Not fully evaluating cost-saving possibilities beyond the construction phase.* DOE started and is moving forward on the waste treatment project without fully completing or conducting some of the rigorous analyses needed to determine the most desirable approach for separating waste components before further treatment. For example, as specified in its construction contract, DOE plans to use a material called "resin" to separate high-level components from the waste. The resin DOE selected in 2000 is available only from a single supplier, and DOE officials have been slow to study alternative resins that could reduce operating costs of the separation facility. Instead, DOE has continued to depend on the production capability and pricing constraints of the single supplier, even though other—potentially less expensive—alternative resins exist. Finally, in late February 2004, DOE decided to more fully assess the cost and risks of relying on a single supplier for the resin. But because of the time required to test and certify an alternative resin, the new material may not be available in time for commissioning and beginning operation of the separation facility. As a result, DOE's project manager estimated that this lost opportunity could increase project operation costs by at least $50 million a year. DOE's slowness in pursuing an alternative resin stemmed from its focus on achieving the near-term goal of having an operating plant by 2011 and its belief that pursuing the alternative, cost-saving option could jeopardize achieving that goal.

- *Inadequate planning to assess and mitigate the effects of a legal challenge to DOE's overall approach to treating and disposing of high-level radioactive waste.* DOE's strategy for treating the waste—not only at Hanford, but also at its other high-level waste sites at Savannah River and the Idaho National Laboratory—is predicated on a key legal assumption that has been successfully challenged in court. The treatment strategy rests heavily on DOE's ability to determine that a majority of its tank waste can be classified as other than high-level waste and treated with less expensive technologies. DOE recently lost a court decision on this matter and is appealing the ruling. DOE has also pursued, unsuccessfully as of May 2004, a legislative remedy that has instead raised concerns about whether the department is attempting to

avoid treating some of its waste in an appropriate manner. If DOE has to change its current approach to treating and disposing of its waste, the change would have a major impact on cleanup of Hanford's tank wastes as well as those at DOE's other high-level waste sites. DOE has developed only rough estimates of potential cost and schedule impacts that this legal challenge poses, including near-term delays and overall effects on cleanup. These estimates for the Hanford Site range from about $350 million for delays if the lawsuit is resolved in DOE's favor, to possibly more than $19 billion in delays and changes to the program if the decision against DOE is upheld. The Hanford estimate is part of a complexwide estimate of more than $100 billion if the lawsuit is not resolved in DOE's favor. Our review indicates that these estimates may be significantly understated. During our review, DOE officials said they believe that their cost estimates and risk-mitigation plans are adequate, and that no further analysis is needed because DOE will ultimately succeed in the appeal or its legislative efforts. In our view, however, a more thorough analysis and full disclosure are needed concerning the potential risk this legal issue poses to the waste treatment project at Hanford and DOE's other sites, including potential impacts on the project's cost and schedule and the environmental risks associated with further delays. We believe full disclosure is important so that policy makers and others can undertake a more informed debate about DOE's high-level waste program.

We are recommending that DOE (1) more closely follow its project management order and implementing guidance when developing and carrying out complex nuclear waste cleanup projects at Hanford and other DOE sites and (2) develop and disclose to Congress a full and complete estimate of the costs and time frames required to dispose of Hanford's and the rest of DOE's high-level tank wastes if, to comply with the law, DOE must dispose of a majority of its tank wastes in a high-level waste repository.

DOE agreed to follow more closely its project management order and guidance and to develop more complete information on the costs if DOE is required to dispose of a majority of its tank wastes in a high-level waste repository. However, DOE said it was unwilling to develop an alternative treatment and disposal plan until the outcome of the legal appeal has been determined. We believe that to be meaningful, any cost and schedule estimates DOE develops should be based on a specific alternative treatment plan.

Background

DOE's Hanford Site in southeastern Washington State was established in 1943 to produce nuclear materials for the nation's defense. This production mission entailed dissolving used ("spent") nuclear fuel to remove plutonium, uranium, and other materials and generated large volumes of high-level radioactive wastes. The wastes' radioactive components decay in a process in which atoms of a radioactive element (also known as a "radionuclide") spontaneously release dangerous radiation. Even short periods of exposure to intense radiation can cause health problems, including radiation sickness, burns, and even death. Because of the intense radiation emitted from high-level waste, the waste must be isolated and handled remotely behind heavy shielding. Some of the radioactive components can be very mobile in the environment and, if not checked, may migrate quickly to contaminate soils and groundwater. In addition to radioactive components, DOE's high-level waste generally also contains hazardous components—including solvents, caustic soda, and heavy metals such as chromium. Radioactive waste components combined with hazardous components are referred to as "mixed wastes."

Although DOE stopped producing nuclear material at Hanford in 1989, high-level waste tanks on the site now contain more than 55 million gallons of sludge, liquid, and a sandlike material called "saltcake." This Hanford tank waste represents about 35 percent of the radioactivity and almost 60 percent of the high-level waste inventory (by volume) within DOE. Hanford's 177 underground waste tanks were constructed between 1943 and 1986. The oldest 149 tanks have single-layer walls, or shells, and DOE has reported that 67 of these tanks are assumed to have leaked waste into the soil. All of the single-shell tanks are beyond their design life. The 28 newest tanks have double-shells and are still in use, and DOE reports that these tanks have not leaked. Since 1989, DOE has spent about $7 billion to manage the waste and explore possible ways to treat and dispose of the wastes. As of May 2004, none of the high-level waste at Hanford has been treated for final disposal.

Treatment and disposal of high-level waste produced at DOE facilities, including Hanford, are governed by a number of federal laws that define the role of DOE and the Nuclear Regulatory Commission (NRC) in waste management. The Atomic Energy Act of 1954 (AEA) and the Energy Reorganization Act of 1974 established responsibility for the regulatory

control of radioactive materials, including DOE's high-level wastes.[4] The Energy Reorganization Act of 1974 assigned NRC the function of licensing facilities that are authorized for long-term storage of high-level radioactive waste generated by DOE and others.[5] The Nuclear Waste Policy Act of 1982, as amended, defines high-level radioactive waste as "highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing, and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and…other highly radioactive material that the [NRC]…determines…requires permanent isolation."[6] The act also established a process for developing and siting a geologic repository (a permanent site deep underground) for the disposal of high-level waste and spent fuel.

DOE's past efforts to treat and dispose of Hanford's tank wastes have been costly but have resulted in little progress. DOE's initial cleanup strategy, developed in 1989, was to immobilize the wastes stored in the 28 most modern tanks because the department knew the most about the waste constituents in those tanks. DOE planned to defer until at least 2003 in deciding what to do with the waste in the remaining 149 tanks. The department spent about $23 million on renovating a World War II-era facility, in which it planned to conduct initial waste processing, before determining that the facility could not be upgraded to meet environmental standards. DOE abandoned this project in 1991. DOE continued designing a waste treatment facility, known as the Hanford Waste Vitrification Plant,[7] that, beginning in late 1991, was expected to process the waste from all 177 tanks. The resulting design, however, was too small to treat all of the waste in a time frame acceptable to regulators. In addition, under this scenario,

[4]The AEA authorized the Atomic Energy Commission (AEC) to provide for the safe storage of radioactive waste from defense-related activities. 42 U.S.C. § 2121(a)(3). Later, the Energy Reorganization Act of 1974 abolished the AEC, transferring responsibilities to the Energy Research and Development Administration (ERDA)—DOE's predecessor—and NRC. 42 U.S.C. §§ 5814, 5841. In 1977, ERDA was abolished, and its functions were transferred to the newly established DOE, explicitly leaving the management of the government's radioactive waste in the hands of DOE. 42 U.S.C. §§ 7151(a), 7133(a)(8).

[5]42 U.S.C. § 5842.

[6]42 U.S.C. § 10101(12).

[7]Vitrification is a thermal process of mixing the waste with glass-forming materials and melting it into glass. The glass is then poured into canisters for long-term storage or disposal.

DOE would have completed the treatment facility before other aspects of the waste treatment program were fully developed—such as retrieving the wastes from the tanks. DOE abandoned this plan in 1993, after spending $418 million. DOE's next cleanup attempt, begun in 1995, involved shifting more of the project and performance risk from DOE itself to its contractor through an approach called "privatization." Under a fixed-price contract using this approach, the contractor would design, finance, build, commission, and operate waste treatment facilities on the Hanford Site for DOE. The department would pay the contractor for successfully processed waste placed in canisters. The first phase of this project was to involve treating about 10 percent of the waste, at a contract price of $3.2 billion. Between 1996 and 2000, however, the proposed contract price soared to more than $14 billion. In June 2000, DOE canceled the contract, after spending about $300 million, mostly on plant design. In December 2000, DOE awarded a new $4.3 billion "cost-reimbursable" contract with performance fee to complete the waste treatment plant that the previous contractor had begun to design.[8] In August 2002, DOE revised the project to more effectively meet regulatory milestones. DOE renegotiated the contract in April 2003 to reflect this revision and to address construction problems. In this report, we refer to DOE's December 2000 plan as the "previous approach" and the August 2002 strategy as the "accelerated approach." (Table 1 summarizes key project events discussed in this report.)

[8]Cost-reimbursement contracts provide for payment of allowable incurred costs as prescribed in the contract. These contracts establish an estimate of total cost and set a ceiling that the contractor may not exceed, except at its own risk, without the approval of the contracting officer.

Table 1: Key Events in the Hanford Waste Treatment Project

Date	Activity
December 2000	Award of plant construction contract to Bechtel National (previous approach)
July and September 2002	Independent reviews of the construction contract cost and schedule
April 2003	Bechtel National contract modification approved (accelerated approach)
May 2005	Alternative treatment demonstration to begin
July 2011	Bechtel National contract planned completion date
February 2018	Regulatory milestone to complete treatment of 10 percent of the waste by volume (25 percent of the radioactivity)
December 2028	Regulatory milestone to complete treatment of Hanford's tank waste
2046	Previous DOE baseline date for completing treatment of Hanford's tank waste

Source: Compiled by GAO from DOE data.

Problems at Hanford and other DOE sites have led DOE to institute reforms in contract and project management. DOE relies almost entirely on contractors to carry out its production, research, and cleanup missions. The department's history of inadequate management and oversight and of failure to hold its contractors accountable for results led us in the early 1990s to designate DOE contract and project management as a high-risk area vulnerable to fraud, waste, abuse, and mismanagement. In response to these and other criticisms, DOE took steps to reform its contracting and project management practices. On the contracting side, in February 1994, DOE issued a report—*Making Contracting Work Better and Cost Less*—containing 48 recommendations in three key areas: selecting alternatives to traditional contracting arrangements used for management and operation of its sites, increasing competition to improve performance, and developing and using performance-based contracting tools. On the project management side, after a series of critical reviews by the National Academy of Sciences and others, DOE issued order 413.3 in October 2000, which defined requirements for DOE project management. These requirements include following a formal planning and decision process;

developing key management tools, including an acquisition strategy;[9] and implementing effective management practices, such as minimizing project risk by developing mitigation strategies. DOE has implemented order 413.3 through detailed guidance it adopted in March 2003.[10]

DOE carries out its tank waste cleanup program under the leadership of DOE's Assistant Secretary for Environmental Management and in consultation with a variety of regional and local stakeholders. In addition to the Environmental Protection Agency (EPA) and state environmental agencies, which have regulatory authority in the states where the sites are located, stakeholders include county and local governmental agencies, citizen groups, advisory groups, and Native American tribes. These stakeholders make known their views through various public involvement processes, including site-specific advisory boards. Over the years, much of the cleanup activity has been implemented under compliance agreements between DOE and regulatory agencies. These compliance agreements provide for establishing legally enforceable schedule milestones governing the work to be done. The operation of Hanford's tank waste program is regulated under the Hanford Federal Facility Agreement and Consent Order between DOE and Washington State's Department of Ecology and EPA. This agreement, commonly called the "Tri-Party Agreement," was signed in May 1989.[11] At Hanford, DOE manages the project through its Office of River Protection, which is a congressionally established organization created in December 1998 to manage tank waste issues. The office has a staff of about 110 DOE employees and a fiscal year 2004 budget of about $1.1 billion. It manages Hanford's tank waste cleanup through two main contracts: a construction contract with Bechtel National for a tank waste treatment plant and a tank farm operations contract with CH2M Hill Hanford Group (CHG). Through its contract, CHG manages various activities in support of the waste treatment project, including planning for

[9]An acquisition strategy establishes a framework within which detailed project planning and execution are accomplished. An acquisition strategy defines an acceptable approach to meeting mission requirements and the relationships between essential project elements, such as project management, worker safety, and contract administration.

[10]In this report, we refer to DOE's order 413.3 and implementing guidance as its "project management initiative."

[11]The purpose of the Tri-Party Agreement is to ensure that environmental impacts associated with past activities are addressed and that environmental laws are complied with. The agreement covers many other site activities in addition to the tank wastes. It also outlines a process for modifying the agreement if needed.

the overall project, developing alternative treatment technologies, storing the tank waste until treatments are available, and preparing to retrieve the waste from the tanks for treatment.

DOE Has Revised Its Cleanup Approach to Reduce Costs and Save Time in the Long Term but Has Increased the Cost of Its Major Construction Project in the Short Term

By accelerating and otherwise adjusting its previous approach to the tank waste project—which was unlikely to meet required deadlines—DOE estimates that it can shorten the project's overall time frame by almost 20 years and lower the cost from more than $50 billion to less than $30 billion. To achieve these goals, DOE has expanded the capacity of the reconfigured treatment facilities and made other changes to the construction phase of the project. These changes, plus contractor performance problems, have increased the $4.3 billion construction contract signed in 2000 by 33 percent, or $1.4 billion, bringing the total contract price for the construction project to $5.7 billion. DOE still expects to begin operating the waste treatment plant by 2011.

DOE's Previous Cleanup Approach Unlikely to Meet the Required Deadlines

DOE's December 2000 previous approach to the tank waste project did not define project activities beyond 2018. The department's plan consisted of (1) a first phase during which facilities would be constructed and about 10 percent of the waste would be processed by 2018 and (2) a second phase during which treatment capacity would be added and the remaining waste would be treated. The plan involved constructing three main treatment facilities—a waste separation facility, a high-level waste vitrification facility, and a low-activity waste vitrification facility—as well as various support facilities. Once the plant was commissioned, DOE intended to separate 10 percent of the waste by volume (and about 25 percent of the total radioactivity) into high-level and low-activity portions of the waste[12] and then vitrify the separated wastes in two treatment facilities, one for high-level waste and the other for low-activity waste. DOE plans to eventually dispose of the high-level waste in a geologic repository. Although DOE had planned to stabilize the low-activity waste through vitrification as well, it plans to dispose of this waste at a facility to be constructed on the Hanford Site. To accomplish treating 10 percent of the

[12]There is no statutory or regulatory definition of low-activity waste. At Hanford, DOE defines it as solidified waste that qualifies as mixed low-level waste because it is treated to remove radionuclides to below 10 C.F.R. Part 61 Class C concentrations and has been shown to meet performance objectives equivalent to those in 10 C.F.R. Part 61 Subpart C. In this report, we refer to this portion of the waste as "low-activity waste."

waste by 2018, DOE designed treatment facilities with the capacity of 1.5 metric tons per day of high-level waste glass and 30 metric tons per day of low-activity waste glass. Although DOE reported that this treatment capacity was sufficient for the project's first phase, it was not sufficient for treating the remaining 90 percent of the waste. Therefore, near the end of the first phase of the operations project in 2018, DOE intended either to expand the existing treatment facilities' capacity or to adopt another approach. DOE had agreed with its regulators—the state of Washington and EPA—to more fully define the project's second phase by 2005.[13]

Under the previous approach, for the second phase of the operations project, DOE planned to expand the capacity of the treatment facilities in 2018 to 6 metric tons per day of high-level waste glass and 60 metric tons per day of low-activity waste glass and to extend project activities until 2046—18 years beyond the date agreed upon with regulators. This decision came from a DOE assessment of the requirements for the project's second phase, which led the department to conclude that it could not finish waste treatment by 2028. To meet its regulatory commitment to complete treating all of the waste by 2028, DOE recognized that it would need considerable capacity beyond what could be added to the first-phase treatment facilities. However, DOE also determined that it was not feasible to obtain the several billions of additional dollars needed to construct waste treatment facilities beyond what was already under construction. DOE officials concluded at the time that the proposed expansion was the best the department could do, and that it would need to renegotiate the current 2028 regulatory deadline for completing waste treatment with EPA and the Washington State Department of Ecology.

Accelerated Approach Defined a Complete Project That Would Meet Regulatory Deadlines and Reduce Costs

In August 2002, DOE defined an accelerated approach to address the processing of Hanford's tank wastes. According to the department, this new approach would reduce environmental risk more quickly, save billions of dollars over the previous approach, and allow DOE to meet its regulatory commitment to complete waste processing by 2028. This accelerated approach grew out of a DOE-wide effort to reexamine cleanup and to find ways to accelerate risk reduction and reduce overall cleanup

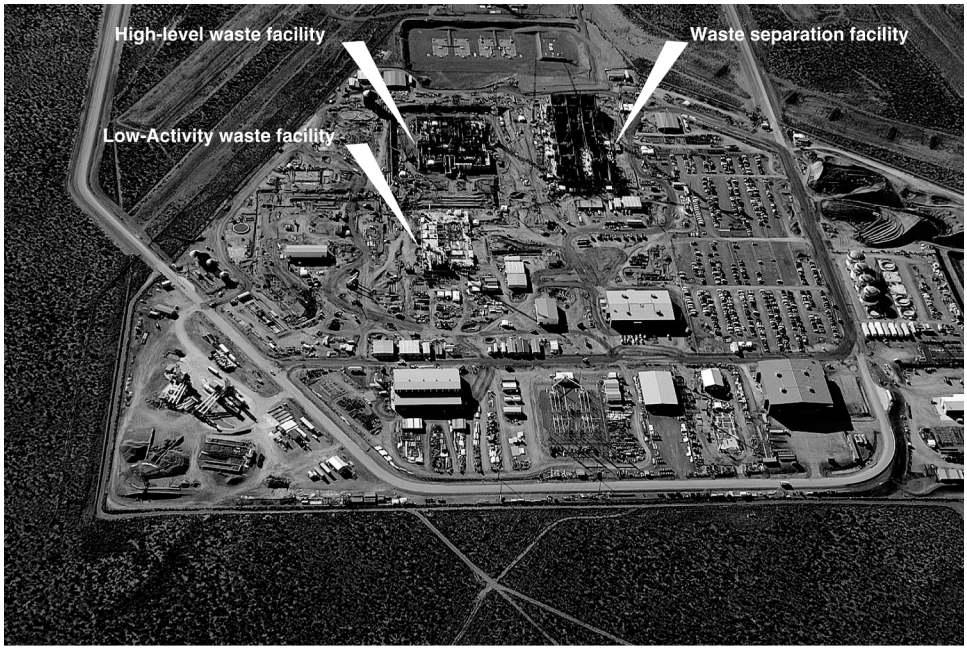
[13]In the Tri-Party Agreement, DOE has agreed to retrieve and treat at least 99 percent of the waste altogether. If the department succeeds, about 500,000 gallons of waste, known as the "tank heel," will remain when the tanks are closed. Tank heel waste and DOE's method of tank closure are outside the scope of our review.

costs. In addition, DOE officials saw the accelerated initiative as a possible vehicle for completing tank waste treatment by 2028 instead of 2046.

DOE's accelerated approach at Hanford differs substantially from the department's previous approach and has three main elements:

- *Increasing the capacity of treatment facilities now under construction.* Under the accelerated approach, the waste treatment plant was modified to increase waste treatment capacity. Instead of one "melter" able to produce 1.5 metric tons of waste glass per day in the high-level waste vitrification facility and three melters able to produce a total of 30 metric tons of waste glass per day in the low-activity waste vitrification facility, DOE decided to incorporate two higher capacity melters for treating high-level waste and two higher capacity melters for treating low-activity waste. DOE expects the expanded facilities to have the capacity for 6 metric tons of high-level waste glass and 36 metric tons of low-activity waste glass per day. Figure 1 shows the plant under construction.

Figure 1: Aerial View of the Waste Treatment Plant, March 2004



Source: DOE photo.

- *Finding an alternative treatment approach for about 60 percent of the low-activity waste.* Under the accelerated approach, DOE has researched a number of alternative ways to treat a large portion of the low-activity waste at facilities other than the low-activity waste plant now under construction. The main alternative DOE is currently investigating involves vitrifying about 60 percent of the low-activity waste directly in the disposal container—a process called "bulk vitrification." In 2004, DOE plans to begin constructing a pilot facility to further develop and demonstrate the bulk vitrification process. If the 2-year test is successful, DOE plans to construct a bulk vitrification facility near the other waste treatment facilities now under construction. In addition, DOE continues to support development of another potential treatment technology for this waste, a thermal treatment process called "steam reforming."

- *Disposing of waste whose characteristics are consistent with transuranic waste without vitrifying it.*[14] As another alternative for treating part of the waste, DOE has identified 2 to 3 million gallons of tank waste that it manages as high-level waste but believes the waste does not require treatment and disposal as high-level waste. DOE has reported that its analysis of tank records shows that waste in those tanks does not come from reprocessing of spent fuel and, therefore, does not meet the legal definition of high-level waste. DOE plans to manage this waste as transuranic waste and, after drying and packaging the waste, ship it to the Waste Isolation Pilot Plant in New Mexico for disposal. DOE estimates that this approach, if approved by regulators, could shorten the operating project time frame by at least 3 years.

DOE expects that its accelerated approach will enable it to avoid building another large waste treatment plant and still meet the regulatory deadline of completing waste processing by 2028.[15] DOE also expects that accelerating treatment to a completion date of 2028 will reduce overall project costs from about $56 billion to about $27 billion. The difference

[14]Transuranic waste is defined as waste containing radionuclides with atomic numbers higher than 92 (the atomic number of uranium) and half-lives longer than 20 years in concentrations exceeding 100 nanocuries per gram. 42 U.S.C. § 2014(e)(e), 40 C.F.R. § 191.02(i).

[15]The Tri-Party Agreement requires DOE to report by January 2005 on the status of its revised approach and submit by January 2006 an updated plan for completing waste processing.

between the two DOE estimates is $29 billion, but DOE has stated publicly that it expects to achieve savings of $20 billion by accelerating the project. However, we believe that DOE's cost-savings estimate is significantly overstated. (See app. II for a discussion of our concerns about DOE's cost-savings estimate.) Table 2 summarizes the overall differences between DOE's previous approach and its accelerated approach.

Table 2: Comparison between DOE's Previous Approach (December 2000) and Accelerated Approach (August 2002) for Processing Hanford's Tank Waste

	Previous approach		
Element of approach	**Capacity from 2011 to 2018**	**Capacity after 2018**	**Accelerated approach**
Daily treatment capacity of treatment facilities:			
High-level waste glass	1.5 metric tons/day	6 metric tons/day	6 metric tons/day
Low-activity waste glass	30 metric tons/day	60 metric tons/day	36 metric tons/day
Role of alternative treatment approaches, such as bulk vitrification	None	None	Treat 60 percent of low-activity waste
Overall treatment completed	N/A	2046	2028
Life-cycle cost (2003 to completion in nominal dollars)	N/A	$56 billion[a]	$27 billion[a]

Source: Compiled by GAO from DOE data.

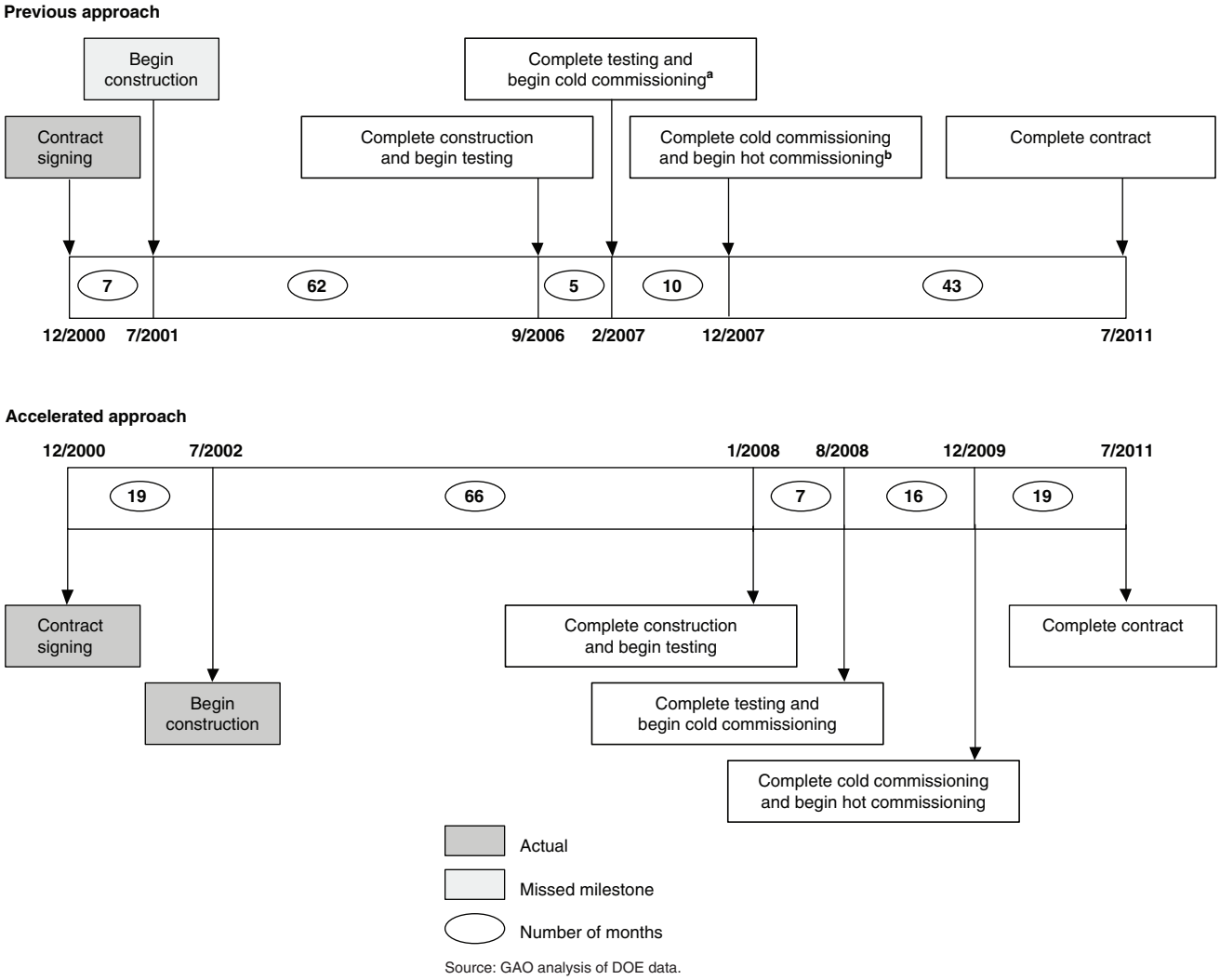
[a]The difference between the two DOE estimates is $29 billion, but DOE has stated publicly that it expects to achieve a savings of $20 billion by accelerating the project. Neither savings figure represents savings DOE can expect to realize, however, because its cost estimates have not been properly developed. To address these problems, we used a present-value analysis, in which dollars are discounted to a common year to reflect the time value of money. See appendix II for a comparison of DOE's estimated savings with our calculation.

Accelerated Approach and Other Project and Contractor Performance Issues Have Lengthened the Design and Construction Phases and Increased Contract Price by $1.4 Billion

DOE renegotiated its contract with Bechtel National to address several factors, including accelerating the overall project to adjust for the project's changed scope, revising the project schedule to increase construction time, resolving contractor claims, and overcoming contractor performance problems that had occurred to that point. The project's changed scope required design rework and other equipment and facility changes to add capacity in the treatment facilities and to separate a planned analytical laboratory from the waste separation facility. For example, in the high-level waste treatment facility, the contractor had to increase individual floor heights, resulting in the building height increasing 7 feet, to ease the complexity of construction and for added operational flexibility. DOE has estimated that these changes in scope will cost about $250 million.

DOE and Bechtel National have also agreed that about $325 million in increased cost stems from Bechtel's engineering and project management problems as well as from delays in completing design work. DOE and Bechtel National have not agreed on the cause of the remaining $850 million in cost increases, which resulted from estimation errors and omissions and from various design and construction issues. However, DOE and Bechtel National resolved the disputed $850 million by changing the contract and modifying the performance incentives to hold the contractor more responsible for future cost increases. As a result of the contract renegotiation, the contract price has risen by $1.4 billion (33 percent), to $5.7 billion. In addition, the dates for certain interim steps of the construction project have been modified, although the completion date for the contract remains the same so that DOE can maintain its schedule to begin operations of the waste treatment plant by 2011 (see fig. 2)

Figure 2: Key Construction Project Dates: DOE's Previous Approach Compared with Its Accelerated Approach



Source: GAO analysis of DOE data.

[a]Cold commissioning refers to testing facilities using simulated tank waste.

[b]Hot commissioning refers to testing facilities using actual tank waste.

Contract Performance Reforms Were in Place at Start of Project, Project Management Reforms Were Added Later

When the contract was originally awarded in 2000, DOE implemented key elements of its contract performance initiative but chose not to implement its project management reforms. At the time, DOE had just adopted the project management reforms resulting from its project management initiative, but implementing guidance was not in place. As the waste treatment project got under way and performance problems began to surface, DOE began to put in place many of the project management initiative's key elements.

Key Contract Performance Reforms Were in Place When Contract Was Awarded

At the time of the December 2000 contract award, DOE was implementing key elements of its contract performance initiative throughout the DOE complex to help improve contractor performance and achieve project cost and schedule goals. These elements included ensuring that the type of contract was appropriate for a project's characteristics and risk level, competing contracts to ensure that the government receives the best offer, and using performance-based incentives to reward contractors for good performance and penalize them for poor performance. DOE has worked toward implementing this contract initiative, which includes these key elements, since 1994.[16]

The December 2000 Hanford waste treatment project construction contract incorporated key provisions of DOE's contract performance initiative. For example:

- In accordance with a key element of its 1994 contract performance initiative to select a project-appropriate contract type, DOE decided on

[16]In 1996, we reported on DOE's implementation of the contract performance initiative and noted that although the department had begun to apply the initiative's principles in newly negotiated contracts, full implementation of the initiative's requirements could take years. See U.S. General Accounting Office, *Department of Energy: Contract Reform Is Progressing, but Full Implementation Will Take Years*, GAO/RCED-97-18 (Washington, D.C.: Dec. 10, 1996). Again in 2002, we reported that although DOE had made progress in implementing key requirements on its projects, it needed to take additional actions to ensure that its projects were achieving the improved results this initiative was intended to achieve. See U.S. General Accounting Office, *Contract Reform: DOE Has Made Progress, but Actions Needed to Ensure Initiatives Have Improved Results*, GAO-02-798 (Washington, D.C.: Sept. 13, 2002). Further, a 1999 review by the National Research Council noted that DOE has taken steps to reform its contracting practices but cautioned that major challenges remained, such as to consistently negotiate contracts that are favorable to the government. See National Research Council, *Improving Project Management in the Department of Energy* (Washington, D.C.: June 1999).

a cost-reimbursement contract type for the waste treatment plant. Following our criticisms of DOE's earlier privatization approach,[17] DOE decided that a cost-reimbursement contract with incentive fees would be more appropriate than a fixed-price contract using a privatization approach for the Hanford project and would better motivate the contractor to control costs through incentive fees.

- DOE decided that a competitive procurement was appropriate for the Hanford project. After holding a series of meetings with interested vendors to discuss contract options and how to promote competition, DOE established an open competition for which two competing teams—Bechtel National and Fluor Vitrification Group—offered proposals. DOE selected the Bechtel National team, concluding that it offered the best technical approach and project management, the highest qualifications of key personnel, and the best record of past performance.

- Finally, DOE put in place a performance-based approach to hold the winning contractor accountable for meeting cost and schedule targets. For example, DOE provided Bechtel National with an opportunity to earn up to $276 million in cost incentives if it met a target cost of $3.97 billion. In addition, the contract provided Bechtel National with $20 million more if it met the schedule date of February 2007 for specified testing of the facility. Nevertheless, although the contractor could earn the fee for meeting these goals, the contract also included a provision that retaining all fees above the minimum guaranteed fee was conditional upon the successful completion of plant testing once construction was complete. If the contractor did not successfully test the plant at the end of construction, it would have to repay all of the incentive fees above the minimum. A DOE official involved with the project at the time said this provisional fee concept was intended to follow the contract reform initiative in holding the contractor accountable for the quality of work performed.

After the contract was awarded, however, costs began to increase and delays to occur. In response, DOE further adjusted the contract's incentive structure to encourage the contractor to perform better. For example, the initial contract fee structure stipulated that the contractor would receive a

[17]See U.S. General Accounting Office, *Nuclear Waste: Observations on DOE's Privatization Initiative for Complex Cleanup Projects*, GAO/T-RCED-00-215 (Washington, D.C.: June 22, 2000).

minimum fee of $79 million regardless of performance and set a maximum total fee of $595 million. In a 2003 contract modification, DOE eliminated the minimum guaranteed fee and required the contractor to meet a performance standard to earn any fees. The revised contract sets a maximum fee of $425 million, as follows: $200 million for meeting a target cost, $60 million for meeting four construction completion milestones, $54 million for meeting other schedule requirements, and $111 million for meeting performance-testing criteria demonstrating the facility's ability to treat the waste. DOE made this change following a 2002 review that concluded that the original incentives were not functioning effectively, because the cost had risen to a point where the contractor was no longer incentivized to contain costs. In internal contracting documents, DOE noted that the current incentive structure is better balanced and should increase the contractor's motivation to control costs and, at the same time, improve on-time performance and operations quality.

Project Management Reforms Were Not in Place at Contract Award

Unlike the contract performance initiative, which has existed since 1994, DOE's project management initiative had just been issued at the time of the 2000 contract award. Its provisions were in the early stages of implementation throughout DOE, and no formal implementation guidance had been issued.[18] Based on good project management practices, this project management initiative establishes a more rigorous decision-making process containing specific requirements to be completed at each project decision point. These requirements include preparing an overall project strategy, performing up-front planning, and having a thorough design and review of these plans by headquarters. The initiative also requires conducting risk evaluations of the projects; comparing budgeted with actual expenditures; and completing certain requirements, such as a significant portion of design, before proceeding with construction.

Because DOE had not issued formal guidance under its project management initiative, reforms that the department did not implement in the December 2000 contract included the following:

- The project management initiative requires that a project acquisition strategy be developed during the early planning stages of a project. At

[18]DOE order 413.3—formally adopted in October 2000—identified the basic requirements that DOE officials were to follow in managing their projects. Guidance outlining how the initiative's requirements should be implemented was not adopted until March 2003.

the time of contract award for the construction project, however, DOE did not have an approved acquisition strategy describing how it planned to meet long-term goals for treating all of Hanford's tank waste by regulatory deadlines. Without such a plan, DOE could not demonstrate whether the plant being built under the construction contract would meet the long-term goals.

- DOE's project management initiative stresses that projects must undergo thorough up-front planning. This process includes waiting until a design is at a certain level of completion before setting a firm project price. For simple, less-complex projects, the project management initiative recommends that a design be up to 35 percent complete before setting the project price. Although the initiative does not give a definitive completion design level for more complex projects, according to the Deputy Director for Project Management in DOE's Office of Engineering and Construction Management, the aggregate design of a complex project should adhere to a similar standard, so that a sufficient level of design is completed in order to make a reasonably accurate cost estimate. Waiting until a design is more complete, especially on projects like the Hanford waste treatment plant that are complex, one-of-a-kind nuclear facilities, allows DOE to identify many of the design uncertainties and to estimate costs more accurately. Contrary to guidance adopted in March 2003, however, DOE set its December 2000 contract price when the design was less than 15 percent complete.

- The project management initiative recommends that a project's baseline be reviewed and validated throughout the life of the project. According to independent reviews performed in 2002, DOE awarded the Hanford construction contract with a project cost baseline—$3.97 billion—that had not been appropriately validated.[19] Instead, the contract included a requirement that the contractor review the previous contractor's design and cost—or perform a "due diligence" review—after signing the contract to assess needed changes to ensure that the facility would meet requirements. The independent reviewers concluded that this due diligence requirement had left it ambiguous regarding whether changes in the project's scope proposed by the contractor would be allowed as

[19]See U.S. Department of Energy, External Independent Review, *Independent Cost Review: CD-3C Review of the Waste Treatment and Immobilization Plant Project* (Washington, D.C.: September 2002), and *Report of the Independent Team for the Hanford Waste Treatment Plant Project Review* (Washington, D.C.: July 1, 2002).

contract cost increases. As a result, the project was more vulnerable to increasing costs.

- DOE's project management initiative recommends that cost and schedule baselines be fully achievable and that, to ensure a "high" confidence of success, they build in appropriate contingency funding in case of unforeseen events—that is, additional funding and schedule flexibility based on a project's degree of risk. In the December 2000 contract, however, DOE accepted a project cost and schedule baseline that had only a 50 percent chance of succeeding on time and within budget, according to an internal DOE assessment of the construction contract. A subsequent independent review of the project found that both the project cost and the contingency allowance were too low for a project of this complexity, and the reviewers recommended raising the estimated project cost and the contingency allowance to provide the project with an 80 percent chance of success.

DOE proceeded with the December 2000 contract award without putting these key project management requirements in place for two main reasons. First, according to the former Deputy Manager of the Hanford waste treatment project, the department believed that it had already met the intent of its project management initiative—for example, defining the "mission need," or what the project was intended to accomplish, and specifying certain design and engineering requirements in the early planning and design stages under the previous contractor. DOE also had a system in place to monitor financial information and report on the project's financial status, as required under the project management initiative. Furthermore, the December 2000 contract included requirements for the contractor to develop project management documents either identical or similar to those under the project management initiative. For example, the contract required the contractor to develop a project execution plan, summarizing critical information necessary to manage a project. The contract also required a quarterly risk assessment report, which met certain project management requirements for effective risk management. At the time, the then Assistant Secretary of Environmental Management said that, with these steps, the project had met the "equivalent" of many project management requirements and could move forward, despite not having officially followed the requirements for the earlier planning stages. Second, these decisions were made while the department was undergoing regulatory pressure to keep the cleanup moving forward. For example, after canceling the earlier (privatization) contract in June 2000, DOE committed to awarding a new construction contract by January 2001, and

the state of Washington was threatening to take legal action if DOE missed that deadline. DOE had agreed to begin construction by July 2001, and it wanted to demonstrate that it could meet this regulatory milestone.

Since 2002, DOE Has Been Implementing Management Practices Aimed at Strengthening Management of the Construction Contract

Two independent reviews in the midst of performance problems after the 2000 contract award identified significant project management deficiencies and recommended fuller implementation of project management reforms. These reviews found that many of the required project-planning documents were either in draft form or inadequately prepared. For example, the reviewers found that DOE's draft project execution plan was outdated and incomplete. In addition, the reviewers noted that the December 2000 contract cost estimate was understated, and, therefore, the actual cost of the project had not been communicated to DOE headquarters or to Congress. Furthermore, the reviewers observed that the aggressive schedule in the baseline was unrealistic. Maintaining such a schedule would compound the risk of further unanticipated cost increases. The reviewers recommended that the baseline not be approved with its existing schedule, but rather that the cost and schedule targets be increased to a more realistically attainable goal. In addition to recommendations from these reviews to more fully implement project management requirements, directions in 2002 from the Assistant Secretary for Environmental Management strongly emphasized adhering to project management requirements on all DOE projects.

Following the independent reviews' recommendations, DOE has been implementing its project management initiative on Hanford's waste treatment project, putting in place certain requirements lacking in the December 2000 contract, including the following:

- *Developing a project acquisition strategy.* DOE is now developing a plan (acquisition strategy) for how it will meet overall waste treatment goals for the project. This strategy addresses how DOE can process all of its waste by the 2028 regulatory milestone. As of May 2004, this acquisition strategy was under development.

- *Setting a contract price after design is at a greater level of completion.* When DOE renegotiated the construction contract price of nearly $6 billion in its April 2003 modification, plant design was about 40 percent complete. A March 2003 internal DOE review of the proposed change to the contract price, which is based on a greater level of design completion, stated that the new price appears to be more reasonable.

- *Proceeding with a baseline that has been reviewed and approved.* The Hanford waste treatment project is now operating under a baseline that has been validated and approved by DOE headquarters, and additional management practices have been put into place by the current management to take a more disciplined approach to keeping the project cost and schedule on track. When it renegotiated the contract price in April 2003, DOE had established a "minimum essential" initiative in which it identified areas of work, such as construction of a container storage building, that it believed were not essential to successful project operation, thus helping to reduce the project's overall cost. At the contract renegotiation, DOE identified about $67 million in work that was unnecessary to the project and could be eliminated.

- *Increasing contingency funding for unforeseen cost increases.* The April 2003 revised project baseline included $550 million in contingency funding to allow DOE an 80 percent chance of meeting the contract cost and schedule. To better control the use of this funding, DOE also implemented a joint DOE-contractor managed board to authorize which unforeseen cost increases will be funded using contingency funds. DOE established this board to more tightly ensure that unforeseen project changes do not increase the current cost baseline. In addition to this contingency, DOE also set aside another $100 million for unforeseen technical and programmatic risks.

Even with these steps, further concerns about the project's baseline cost and schedule exist. For example, out of concern about the reliability of the project's renegotiated cost and schedule, the conference report accompanying the Energy and Water Development Appropriations Act for 2004 directed the U.S. Army Corps of Engineers to conduct a detailed, independent review of the project's cost and schedule baseline. The report is to be issued to the House and Senate Committees on Appropriations and may be available to the public by early summer 2004.

Not Implementing Key Project Management Reforms at Start of the Construction Project Has Added to DOE's Challenges

DOE's decision not to implement the project management initiative at the beginning of the Hanford waste treatment construction project has increased the risks and uncertainties the department will face in completing both the construction project and the operations project to clean up the Hanford Site. Three main consequences of DOE's failure to implement project management reforms earlier are heightened risk from using a fast-track approach for plant construction, missed potential cost-saving opportunities, and lack of a sufficient risk management strategy for DOE to address legal challenges to its waste treatment strategy.

Fast-track Project Management Approach Increases the Risk of Encountering Problems

To minimize the time required to complete construction, DOE has followed a fast-track approach to the construction project, carrying out plant design, construction, and technology development activities simultaneously. Under this approach, design and construction activities take place in stages, with construction of some sections of a facility under way before those sections are fully designed. DOE's project management initiative, however, cautions that such a fast-track, design-build approach should be used only in limited situations, such as when work scope requirements are well defined, the project is not complex, and technical risks are limited. When these conditions do not exist, a fast-track approach is a risky management strategy. According to DOE's project management guidance, a fast-track approach to large, complex, one-of-a-kind projects is inherently high risk.

The construction project at Hanford departs from conditions appropriate for fast-track management. For example, DOE has acknowledged that the waste treatment plant is the largest, most complex environmental cleanup project in the United States. The plant incorporates waste treatment processes that have never previously been combined into facilities the size and capacity of those envisioned at Hanford. Furthermore, key uncertainties still exist regarding the condition of the waste to be treated and the best technologies to use for certain treatment processes.

Despite these risks, DOE has chosen this approach to keep the construction project moving forward so that the plant can be completed in time to meet regulatory milestones. DOE selected a contractor for the December 2000 contract award that, it believed, had experience with the fast-track approach and would be able to maintain the contract schedule. DOE also took steps to manage the increased risk associated with a fast-track approach, establishing contingency funding measures in case of

unforeseen occurrences and linking performance fees specifically to cost and schedule goals.

Despite the risk-mitigation actions taken in 2003, the fast-track approach may result in continuing problems on the construction project. For example:

- *Construction is outpacing design, resulting in delays in completing planned work.* Although DOE doubled the funding for engineering and other professional services to help ensure that design work was completed on schedule, construction has outpaced design. This lag has delayed completion of interior walls in the treatment facilities and led to the need to temporarily reassign construction workers to other tasks. According to the DOE construction project manager, the project baseline has not yet been affected, but if the problem persists, both cost and schedule could be affected.

- *Shortening the facility commissioning period may limit plant reliability.* In its April 2003 contract modification, DOE extended the construction schedule by 16 months because of delays and design changes. To complete the construction project by 2011 while increasing the construction phase, DOE reduced by nearly the same period the commissioning phase, when the facilities' complex treatment processes will be tested and brought into sound working order. Because of this shorter commissioning time, DOE reduced the testing to be conducted on actual wastes. As a result, the contractor plans to test only two of Hanford's four waste types during this period. According to experts we contacted, including former DOE and contractor officials and industry technology development managers who have been involved in plant start-up operations, this commissioning approach could overlook significant problems until after the plant becomes fully operational. These experts have noted that corrective actions at that time could be more costly and time-consuming than if the problems were found during the commissioning phase. DOE Hanford managers have countered that although the period for testing plant operations using actual wastes has been reduced, the period for testing simulated waste has been expanded by several months. While they expect operational challenges during the commissioning period, DOE officials believe that their current commissioning strategy will be sufficient to test the plant adequately.

- *Resolving key technical challenges for processing the waste has fallen behind.* To keep the construction project on schedule, DOE has

acknowledged that it needs to expedite the resolution of key technical challenges facing the project. One such challenge involves the generation of hydrogen gas during waste separation activities. The Defense Nuclear Facilities Safety Board stated in October 2002 and again in September 2003 that problems with this flammable gas, involving buildup of gas in excess of safety limits, could result in significant safety and operational problems. Bechtel National has been addressing this issue through design changes. However, even though it has been more than 1 year since the Board first raised this issue, this problem has yet to be fully resolved. An even more critical technical challenge involves how the wastes are mixed during treatment processes. To expedite resolution of this technical challenge, Bechtel National initially decided to rely on computer modeling of special mixers, called "pulse jet mixers." But because computer modeling did not provide adequate assurance that the mixers would work, the contractor decided in April 2003, just 9 months before the design configuration for the mixers was to be completed, to conduct more stringent tests. Efforts to resolve the uncertainties associated with the mixers have delayed the testing schedule by more than 4 months, increased costs by more than $15 million, and postponed the purchase of several thousand feet of pipe for the treatment facilities. In March 2004, Bechtel National reported that modifying the facility design to reflect improvements to the mixers could require an additional $70 million and take about 16 months to complete. In its March 2004 monthly contract status report, Bechtel National stated that such delays have affected the project's critical path and will increase costs.

- *Depending on a technology not fully tested on Hanford tank wastes to meet regulatory milestones*. To meet its regulatory milestone for completing treatment of Hanford's tank waste by 2028, DOE is attempting to incorporate a technology before its effectiveness has been fully demonstrated on Hanford's tank wastes. For example, DOE is relying heavily on the assumption that a treatment technology called "bulk vitrification" will succeed. Although this technology is being managed outside of the scope of DOE's construction project, it is critical to the cleanup program because the technology is expected to treat up to 60 percent of the Hanford's low-activity waste. DOE's current plans depend on this technology to meet its 2028 cleanup date, even though its effectiveness has not been fully tested. As a result, to demonstrate that this technology will work on Hanford's tank wastes, DOE has adopted an aggressive schedule to begin constructing a pilot facility later in 2004 and to conduct formal testing over about 2 years, beginning in May 2005.

Although initial tests with simulated waste have led DOE to consider this technology promising, Hanford's waste management director has stated that the size and treatment capacity of a full-scale plant cannot be confirmed until testing is completed. Because DOE is relying on bulk vitrification to process the majority of low-activity waste, any problems in developing this treatment capability will likely extend the duration of the waste treatment project and increase its overall cost. DOE's initial schedule may already be threatened because awarding a contract to build the test facility is about 6 months behind schedule.

Beyond these potential problems with the construction project, the fast-track approach raises other concerns. First, DOE's construction project manager has acknowledged that the schedule for constructing and testing facilities and concurrently resolving technical issues continues to be high risk. In addition, Bechtel National reported in January 2004 that it was concerned about being able to meet its planned construction schedule. Second, engineering and construction experts we contacted within the industry, national research organizations, and academia expressed concern that proceeding with DOE's fast-track approach could create higher costs, schedule delays, and facilities not fully capable of treating the waste. Third, a 2002 study by the National Research Council reported that DOE should proceed with caution when managing "first-of-a-kind" projects using a fast-track approach.[20] The council concluded that developing technology concurrently with project engineering, design, and construction activities increases an already high degree of uncertainty. The council said such projects are risky, costly, and likely to produce facilities needing significant modifications to ensure that they will work properly. Fourth, the Defense Nuclear Facilities Safety Board cautioned in June 2002, and again in March 2004, that a fast-track approach could lead to expensive plant modifications or to the acceptance of increased public health and safety risks. Finally, DOE's record with the fast-track approach on complex

[20]See National Research Council, *Progress in Improving Project Management at the Department of Energy, 2002 Assessment* (Washington, D.C.: National Academies Press, 2003).

nuclear cleanup facilities is not good.[21] DOE could not identify for us a single instance where this approach to constructing a large, complex nuclear cleanup facility resulted in a project that was completed on time and within budget.

Delays in Evaluating Risks and Costs Associated with Waste Separations May Cost $50 Million or More

DOE has delayed evaluating the most desirable approach to take in separating waste components before further waste treatment can occur. Separating Hanford's waste into its various components is crucial to DOE's treatment and disposal plans, and, as of April 2004, DOE was relying on a single supplier of a costly key substance in the separation process. Waste separation involves sequential filtering and removing major high-level constituents, such as cesium-137 and strontium-90, from the waste. The separation process at Hanford includes a technology called "ion exchange," in which the waste flows through columns containing a specially designed substance, or resin, that chemically collects specific high-level waste components on its surface as they pass through the columns. The high-level waste components are then washed from the resin and accumulated as part of the high-level waste stream. Bechtel National will obtain this resin from a single, small supplier.

DOE faces two significant risks regarding resin supply: acquiring the resin in sufficient quantities to operate the separation facility and the cost of the resin DOE selected. The first risk is that DOE decided to acquire the resin from a small supplier that may not have the long-term production capacity to supply the resin in required quantities—about 6,250 gallons per year. In a December 2003 letter to Bechtel National, the manufacturer stated it can produce 1,600 gallons of resin over a 12-month period to meet initial commissioning needs. Although the manufacturer assured Bechtel National that it will eventually be able to produce enough resin for full-scale treatment operations, as of April 2004, contractor and DOE management officials had not verified that the supplier actually has this

[21]We have reported on the cost and schedule problems associated with DOE's use of a fast-track, design-build approach in our reviews of other DOE projects. For example, see U.S. General Accounting Office, *Nuclear Waste: Hanford Tank Waste Program Needs Cost, Schedule, and Management Changes*, GAO/RCED-93-99 (Washington, D.C.: Mar. 8, 1993); *Nuclear Waste: Department of Energy's Project to Clean Up Pit 9 at Idaho Falls Is Experiencing Problems*, GAO/RCED-97-180 (Washington, D.C.: July 28, 1997); *Nuclear Waste: Process to Remove Radioactive Waste from Savannah River Tanks Fails to Work*, GAO/RCED-99-69 (Washington, D.C.: Apr. 30, 1999); and *Nuclear Waste: Management Problems at the Department of Energy's Hanford Spent Fuel Storage Project*, GAO/T-RCED-98-119 (Washington, D.C.: May 12, 1998).

capacity. These officials stated that they are relying on the manufacturer's December 2003 assurance that it can produce the quantity of resin needed for full-scale operations. Bechtel National stated that it is not responsible for ensuring that the supplier can provide resin beyond its plant commissioning commitments. The second risk is the potentially high cost of purchasing the resin from a single source without price competition. Information obtained in December 2003 indicates that the resin may cost about $10,000 per gallon. Over a single year of operating the separation facility, resin costs alone could amount to about $62 million. According to the project's research and technology manager, however, it may be possible to use an alternative, that may be an equally effective but significantly less expensive resin, that may be available from commercial suppliers. This alternative resin may cost about $1,000 to $2,000 per gallon, or about $6 million to $12 million per year. DOE and contractor officials, including the research and technology manager and the project's manager, confirmed that pursuing an alternative resin could substantially increase the reliability of supply and reduce plant operating costs.

DOE has taken steps to address these project risks, but delays in developing a viable risk-mitigation strategy may cost DOE $50 million a year or more in lost savings opportunities. As early as its December 2000 contract award date, DOE recognized that depending on a single resin source was high risk. Although Bechtel National began evaluating alternative resins in 2002, DOE took no formal action on the issue until 2003. After we and others raised this issue with DOE in early 2003, the department modified the contract in April 2003 to require the contractor to continue research on alternative resins for use as an option to the resin specified in the December contract. Initial testing on alternative resins, completed by the contractor in late 2003, showed promising results for a resin costing significantly less than the original. Given the estimated cost of the two resins, the potential cost savings of using the alternative resin for 1 year of operation could result in a savings of between $50 million to $56 million, according to the project manager. The contractor, however, did not aggressively pursue development of an alternative resin, even though it was authorized to do so, deciding to defer any significant exploration of alternative resins until fiscal year 2007 or later. The contractor explained that an alternative resin was not needed to achieve its contractual commitment of delivering an operational facility. In addition, the contractor was unsure whether it could successfully develop another resin in time for plant commissioning and said that spending money on an alternative resin could worsen projected 2005 and 2006 funding constraints.

In late February 2004, DOE directed Bechtel National to test and qualify an alternative resin in time for commissioning the separation facility. Although testing an alternative resin is important in properly managing project risk, with the limited time to certify an alternative resin, DOE could for several years after treatment operations begin be exposed to the risk of having an uncertain supply of resin available to support waste separation operations and of having to pay a higher cost for the resin. The contractor will have about 2 years to fully test and qualify an alternative resin if the resin is to be available for procurement by mid-2006 and for plant commissioning in 2008. Two years may be too little time because the qualifying process took nearly 10 years for the original resin. Even if the contractor can successfully qualify the resin within 2 years, it will still have to obtain sufficient quantities for plant commissioning. The contractor's research and technology manager told us that this schedule is extremely tight and will be challenging to meet. Thus, DOE may for considerable time be dependent on the production capability and pricing of a single supplier for a substance critical to the waste separation process.

DOE Has Not Adequately Assessed or Mitigated a Legal Challenge to Its High-level Waste Treatment Strategy

A third challenge DOE must address to successfully manage its waste treatment project is to fully assess the risks of a legal challenge to its approach for treating and disposing of the tank wastes and to develop an adequate mitigation strategy for addressing those risks. DOE's project management initiative requires that the department assess significant risks, quantify the potential impacts, and develop a mitigation plan for addressing these risks. DOE, however, has not fully assessed the risks associated with the legal challenge, has only very rough estimates of the potential impacts on the waste treatment project's cost and schedule, and has not developed a comprehensive mitigation strategy.

Legal Challenge to DOE's High-level Waste Treatment and Disposal Strategy Threatens to Derail Cleanup

DOE had developed a process for determining the conditions under which some of its tank wastes could be considered for disposal as other than high-level waste. This process was defined in DOE order 435.1 and was generally called a process for determining that certain waste resulting from reprocessing is "waste incidental to reprocessing."[22] To meet criteria set forth in this order for considering tank wastes as other than high-level wastes, DOE had to determine that the waste (1) has been or will be

[22]The phrase "waste incidental to reprocessing" refers to wastes resulting from reprocessing spent nuclear fuel that DOE considers not to be high-level waste.

processed to remove key radioactive components to the maximum extent technically and economically practical; (2) will be disposed of in conformance with the safety requirements for low-level waste as established in NRC regulations; and (3) will be put in a solid physical form and not exceed radioactivity levels set by NRC for the most radioactive category of low-level waste, referred to as "Class C standard."[23] Once satisfied that these requirements were met for a specific segment of the waste, DOE planned to obtain a technical review of this determination from NRC. NRC's role was to determine whether DOE had appropriately followed the criteria in order 435.1.[24] After a favorable determination from NRC, DOE would have considered the waste segment to be "incidental" waste for purposes of treating and disposing of the waste.

The legal basis of DOE's plan to apply different treatment and disposal approaches to segments of its tank wastes has been challenged in the courts. In March 2002, a lawsuit filed by the Natural Resources Defense Council and others challenged DOE's authority to proceed with its planned approach. The plaintiffs argued that DOE's plan violated the Nuclear Waste Policy Act by allowing high-level radioactive waste to be classified and treated as something other than high-level waste. In a brief in support of their position, plaintiffs expressed the concern that DOE would use its incidental waste determination process to permanently leave intensely radioactive waste in the tanks after only minimal treatment. In a July 2, 2003, federal district court ruling, the court agreed with the plaintiffs that the portion of DOE's order 435.1 setting out its incidental waste determination process violated the Nuclear Waste Policy Act and found that that part of the order was invalid. The court concluded that the act "allows DOE to treat the solids to remove fission products, thereby permitting reclassification of the waste," but does not permit the same option for the liquid portion of the waste, which may not be reclassified and must be treated as high-level waste.[25] This ruling poses a significant barrier to DOE's plan to segment the tank wastes for treatment and disposal purposes, and it raises the possibility that DOE might need to find

[23]As specified in NRC regulations (10 C.F.R. § 61.55(a)(2)(iii)), Class C low-level waste must meet the most rigorous requirements for low-level waste form to ensure stability and requires additional measures at the disposal site to protect against inadvertent intrusion.

[24]Although order 435.1 does not require DOE to obtain NRC's concurrence with its incidental waste determinations, DOE did so to obtain an independent assessment of its evaluation of waste as incidental to reprocessing.

[25]*Natural Resources Defense Council v. Abraham*, 271 F.Supp.2d 1260 (D. Idaho 2003).

an alternative strategy to its accelerated approach for cleaning up Hanford's tank wastes. DOE has appealed this decision.

DOE's Risk Assessment and Mitigation Planning Are Inadequate

DOE's project management initiative defines risk as "the measure of the potential inability to achieve overall project objectives within defined scope, cost, schedule and technical constraints" and emphasizes that all projects should have a risk assessment and mitigation strategy. Such an assessment must identify any technical, cost, or schedule risks to the project; quantify potential cost and schedule impacts; and develop and implement a strategy to mitigate or properly manage those risks. According to the Deputy Director for Project Management in DOE's Office of Engineering and Construction Management, which oversees implementation of DOE's project management initiative, managers should analyze both the consequence to the project if the risk occurs and the likelihood of a risk's occurring. He noted that if the potential impact to the project is significant and the likelihood of a risk occurring is highly probable, DOE managers must develop a formal risk-mitigation plan detailing the potential risks, impacts, and actions taken and planned to best mitigate the risk. The project management initiative describes effective risk management as "an essential element of every project" and makes it clear that risk management should occur continuously throughout a project.

DOE has not conducted a thorough risk assessment of the potential effects of the legal challenge on the Hanford tank waste treatment project. Although a draft internal study concludes that the legal challenge presents a high risk to DOE's high-level waste program,[26] DOE has only very rough estimates of the consequences for its cleanup program. These estimates, which are not part of Hanford's formal risk management plan, cover both near-term impacts on cost and schedule if the lawsuit delays cleanup but is ultimately resolved in DOE's favor and long-term impacts if the outcome continues to go against DOE. The department estimated that in the near term, a 2-year slip in cleanup would cost an additional $350 million at

[26]See Department of Energy, *High-Level Waste—Risk Reduction Project (HLW-RPP): Managing Waste to Reduce Risk—HLW* (Washington, D.C.: May 20, 2003).

Hanford. We found no analysis supporting this estimate.[27] DOE officials said this $350 million near-term estimate was not tied to specific activities on the waste treatment project but represented the approximate cost of an extra year of maintaining waste in the tanks. Regarding the long-term impacts if DOE must treat and dispose of all of its tank wastes as high-level waste, DOE has provided rough, unvalidated estimates for both the Hanford site ($19 billion) and its entire high-level waste program (more than $100 billion). Again, we found little rigorous analysis to support either estimate. For example, the $19 billion Hanford estimate is based, in part, on a configuration and capacity of the low-activity treatment facility that DOE is no longer considering because that configuration could result in an unacceptably high heat load. The Hanford estimate also includes a potential cost of $6 billion to remove and dispose of 149 tanks after waste has been retrieved. Information that DOE provided to us in April 2004, however, indicates this cost could be closer to $67 billion. Further, the $19 billion Hanford estimate does not include the additional costs to DOE for disposing of approximately 86,000 more canisters of treated waste than currently planned in a deep geological repository. On the basis of a recent disposal estimate of $650,000 per canister, this cost alone could add $56 billion to the Hanford estimate.[28] The estimate for Hanford is part of DOE's complexwide estimate of "more than $100 billion" cost impact if outcomes continue to go against DOE. These revised Hanford estimates and other recent information from DOE indicate that the department's complexwide estimate of more than $100 billion may also be significantly understated. For example, within its $100 billion estimate, DOE included $30 billion for disposal of additional canisters that would be produced complexwide. In response to our request, however, DOE acknowledged the $30 billion was too low and recalculated the figure, resulting in a revised estimate of more than $90 billion for this component of its complexwide estimate.

[27]During DOE's fiscal year 2003 financial statement audit, DOE provided its independent auditors with the $350 million estimate for Hanford, based on a delay in selecting a supplemental technology for treating low-activity waste. According to the contractor's project manager, however, as of April 2004, DOE was moving forward with trying to award a contract to test and develop bulk vitrification, the technology DOE has tentatively selected to treat a majority of Hanford's low-activity waste.

[28]DOE originally estimated $30 billion to dispose of approximately 180,000 additional canisters at a geological repository. DOE did not define how much of the $30 billion applied to each site, but recently the department recalculated those costs and acknowledged that this cost could be $43 billion at Hanford alone (based on a per canister cost of $500,000). We used the most recent per canister disposal cost of $650,000 provided to us by the department in arriving at our estimate of $56 billion.

A main aspect of DOE's risk-mitigation planning—its pursuit of a legislative remedy—has also been inadequate.[29] Regarding the legislative remedy, DOE has not been effective in developing complete and objective supporting information and effectively communicating that information to decision makers or other stakeholders. In addition to using only rough estimates, DOE has raised stakeholder concerns about its true intentions. For example, after the court ruling, DOE drafted proposed language to amend the Nuclear Waste Policy Act of 1982, as amended, to give DOE specific authority to make incidental waste determinations.[30] The state of Washington and others raised concerns that the proposed language would leave DOE with too much discretion regarding how to make these determinations. The state of Washington has been concerned that DOE may use such authority to permanently and inappropriately leave highly radioactive waste in the tanks. To date, DOE has not been effective in countering these concerns or in explaining to its stakeholders or other decision makers why the incidental waste determination process is in the public's best interest.

The potential consequences for Hanford's tank waste project, and for DOE's other high-level waste sites, could be far-reaching and significant. DOE's own analysis suggests several consequences could occur. In the worst case, wastes could remain on-site untreated for longer periods of time, posing a continued threat to workers, the public, and the environment. Complexwide, DOE would likely need to find a different strategy to treat all of its tank waste for disposal at a geologic repository. Treated waste, at much larger volumes than now estimated, could overwhelm the currently planned geologic repository, hastening the need for additional repository capacity. For example, DOE estimates that it would need to send an additional 180,000 canisters of waste from all sites to a repository if it must dispose of most of its waste as high-level waste. DOE's current plans call for sending about 20,000 canisters to a repository. Furthermore, the plant now under construction at Hanford may not be configured to most effectively treat waste if all of the waste is destined for

[29]DOE's other main risk-mitigation approach involves appealing the court ruling. After the July 2003 decision, DOE appealed to the Ninth Circuit Court of Appeals. As of May 2004, no date had been set for oral arguments in this case.

[30]Before the court ruling, we had recommended that DOE seek clarification of its authority from Congress. See U.S. General Accounting Office, *Nuclear Waste: Challenges to Achieving Potential Savings in DOE's High-Level Waste Cleanup Program*, GAO-03-593 (Washington, D.C.: June 17, 2003).

a repository. For example, all of the tank wastes may need to be treated through the waste treatment plant, making supplemental technology development unnecessary. Since the current plant would be unable to process all of the tank waste by 2028 without using supplemental technologies, DOE may need to consider alternatives, such as building a second waste treatment plant. DOE does not currently have estimates of these scenarios.

Despite these deficiencies in risk assessment and mitigation planning, DOE believes its current risk assessment and mitigation plan are sufficient. According to DOE, its cost estimates were intended only to illustrate potential impacts to its high-level waste program in a worst-case scenario, and, because the department believes it will ultimately be successful either in the appeals process or through legislative avenues, a more detailed risk assessment is not needed. In our view, the uncertainties associated with this legal challenge to its waste treatment program are precisely why DOE needs a thorough and objective assessment of the risks and a mitigation plan that includes complete and effective communication with decision makers and other stakeholders.

Conclusions

After years of effort and after spending hundreds of millions of dollars and making several false starts, DOE is now constructing a plant to use in treating and preparing for disposal of a major portion of Hanford's high-level tank wastes. But DOE began plant construction before it had a complete acquisition strategy in place, and it is carrying out technology development, plant design, and construction activities simultaneously. In going forward, DOE faces significant challenges that will likely continue to affect cost and completion dates, including the challenge of continuing to manage concurrent development, design, and construction. DOE will need to minimize the cost and schedule growth that will likely continue and to take full advantage of cost-reduction opportunities over the life of the project. DOE must also carefully assess and manage the implications of legal challenges to its overall approach to treating and disposing of high-level tank wastes. We believe that full disclosure of the potential impacts to its high-level waste program is important so that policy makers and others can undertake a more informed debate.

Recommendations for Executive Action

We recommend that the Secretary of Energy take the following two actions:

- follow more closely DOE's project management order and implementing guidance when acquiring complex nuclear waste treatment plants at Hanford and other DOE sites, especially by avoiding a fast-track, concurrent approach to the design, technology development, construction, and testing of such plants, and

- develop and provide to Congress a plan that includes an estimate of the costs and time frames needed to treat and dispose of Hanford's and the rest of DOE's high-level tank wastes if the current court ruling is upheld and if a majority of DOE's tank wastes must be disposed of in a high-level waste repository.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for review and comment. In written comments, DOE's Assistant Secretary for Environmental Management generally agreed with the report's recommendations. The Assistant Secretary also provided technical comments as an enclosure to the letter, which we have incorporated as appropriate. DOE's written comments on our draft report are included in appendix III.

Regarding the report's two recommendations, DOE agreed to follow more closely its project management guidance when acquiring complex nuclear waste treatment plants, especially by avoiding a fast-track, concurrent approach to designing and constructing such plants. Concerning our recommendation to develop and provide to Congress a plan that includes an estimate of the costs and time frames to treat and dispose of DOE's high-level wastes, if a majority of the wastes must be disposed of in a high-level waste repository, DOE agreed that it should develop more complete information on the costs to give Congress a better sense of the magnitude of those costs. However, DOE said it was unwilling to develop an alternative treatment and disposal plan until the outcome of the legal appeal has been determined. In our view, to be meaningful, any cost and schedule estimates that DOE develops should be based on a specific alternative treatment plan.

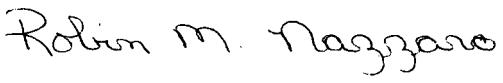
In an enclosure to the letter, DOE disagreed with our view that it should use present values when disclosing the cost savings between alternative approaches. DOE said that present-value techniques tend to hide the full

value of future costs due to discounting, and that using current dollars provides for a more direct comparison with a project's life-cycle cost and DOE's budget. However, although using current dollar estimates may be appropriate for budget purposes, as we discuss in our report, standard economic analysis as well as Office of Management and Budget guidelines (see app. II), state that present-value analysis is the standard methodology to use for comparing costs of different alternatives that occur at different times (e.g., DOE's accelerated and baseline approaches). Present-value analysis reflects the time value of money—that cost savings are worth more if they are incurred sooner and worth less if they occur in the future. Contrary to DOE's comment that present-value techniques "hide" the full value of future costs, present-value analysis reveals the true costs of projects and is the appropriate method to use to reliably estimate and compare costs.

DOE also disagreed with our statement that its $20 billion cost-savings estimate for the Hanford waste treatment project is overstated and misleading. We believe DOE's $20 billion cost-saving estimate is overstated because it is not based on a present-value analysis as discussed above, and the estimate is misleading because it is a point estimate that does not consider uncertainties inherent in the waste treatment project and implies a degree of accuracy that is not warranted. Furthermore, as we noted in the report, DOE's $20 billion cost-saving estimate could not be derived from DOE's reported costs for its baseline and accelerated approaches. (See app. II.)

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this report. At that time, we will send copies to other interested congressional committees and to the Secretary of Energy. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions on this report, please call me on (202) 512-3841. Other staff contributing to this report are listed in appendix IV.



Robin M. Nazzaro
Director, Natural Resources
and Environment

Scope and Methodology

To develop information on the Department of Energy's (DOE) cleanup strategy for Hanford tank waste and how the strategy has evolved since December 2000, we analyzed information and documents provided by DOE officials and contractors at the Hanford Site and DOE headquarters. We also toured the project's construction site. To assess the construction contract, including its cost and schedule, we reviewed the contract; contract modifications; and related documents, including the contractor's monthly progress reports and independent and headquarters reviews, and analyzed various related studies. We also discussed the progress of the project with Washington State regulators and Environmental Protection Agency officials; DOE headquarters officials, including the Assistant Secretary for Environmental Management; and Bechtel National, Inc., (Bechtel National) officials. To assist in evaluating the technical aspects of DOE's approaches, we obtained assistance from our technical consultant, Dr. George Hinman, who has a Doctor of Science degree in physics and is Professor Emeritus at Washington State University. Dr. Hinman has extensive nuclear energy experience in industry, government, and academia. To develop information on the impact of DOE's initiative to accelerate cleanup of the waste, we reviewed DOE reports and studies and discussed them with key headquarters and field staff. We also reviewed various studies on the proposed supplemental technologies and other methods being considered by DOE and discussed them with program officials at the Hanford Site and DOE headquarters. We also discussed these issues with Washington State regulators. We relied on dollar figures as provided by DOE but took various steps—such as reviewing cost validation reports, analyzing budget formulation documents, documenting cost estimating assumptions, and obtaining clarifications from DOE budget officials—to ensure that these data were sufficiently reliable for purposes of this report. To estimate the potential savings from accelerating the project, we analyzed DOE's life-cycle cost estimates using a commercially available risk analysis program called "Crystal Ball" (see app. II). We did not assess DOE's efforts to address any waste remaining in the tanks after retrieval is completed or DOE's plans to close the tanks. Both of these topics were outside the scope of our review.

To examine the extent to which DOE's contract performance initiative and project management initiative have been implemented on the Hanford project, we reviewed DOE's contract reform report—*Making Contracting Work Better and Cost Less*—and DOE order 413.3 and its implementing guidance. We interviewed DOE headquarters officials from the Office of Engineering and Construction Management and the Office of Procurement Assistance. We reviewed the original and modified contract, related project

management documentation, and various reviews of the project. We gathered documentation on contract reforms and project management reforms at Hanford and also interviewed DOE officials at Hanford. We discussed contract management and project management issues with outside experts, including staff from the National Academy of Sciences, the U.S. Army Corps of Engineers, experts who took part in the 2002 reviews of the waste treatment contract, and staff from the Department of the Navy's Nuclear Naval Program.

To determine the impact of DOE's fast-track, design-build plant construction approach on contract success, we reviewed various DOE and contractor studies and interviewed knowledgeable officials. In addition, we discussed this approach with several independent experts, including a former senior manager of DOE's environmental management program, an Exxon operations manager involved in facility start-up operations, and our technical consultant, to obtain their views on any benefits or potential risks DOE is facing. To determine the potential cost and schedule impact associated with the resin needed for DOE's waste separation plant, we reviewed DOE and contractor studies, risk assessments, and cost and schedule evaluations. We discussed the implications of these studies with the officials involved; our consultant, Dr. Hinman; and DOE and contractor officials.

To address the legal challenge DOE faces, we obtained DOE's summary estimates of life-cycle cost and schedule impacts to its high-level waste program at its three high-level waste sites if DOE lost the current court challenge. We also obtained summary information relating to DOE's estimate of near-term cost increases to its overall high-level waste program if a 2-year delay in the program occurred. DOE provided a summary table that showed, by site, such information—including additional years of treatment processing needed if litigation outcome was unfavorable, additional number of high-level waste canisters that would need to be produced, and additional storage costs. For the Hanford Site, we also requested, and DOE provided, more detailed analysis supporting its summary near term and longer term estimates. The information DOE provided included a summary cost comparison of four different waste treatment scenarios, including the current approach DOE is following. We also obtained from DOE basic assumptions used in calculating these scenarios and qualifications to these data. We discussed the Hanford estimates with DOE officials. In addition, we obtained from key DOE officials responses to a series of questions focusing on the reliability of the Hanford estimates. These questions covered issues such as the

methodology used to develop the estimates, internal review of the estimates, and confidence level associated with the estimates. Also, because these same estimates—for DOE's entire high-level waste program, not just Hanford—were reported in note 17 in DOE's *Fiscal Year 2003 Performance and Accountability Report* (financial statements), we interviewed the auditors who performed the review of the financial statements for DOE. We obtained the auditors' supporting documentation and discussed with them the reliability of these estimates. Given our review of the documentation provided by DOE and our discussions with DOE officials, we have reservations about the reliability of these data. These issues are discussed in this report.

For determining DOE's risk-mitigation efforts, we gathered documentation relevant to DOE's legislative proposal. We discussed DOE's risk-mitigation strategy with officials from the state of Washington. We also asked DOE to provide its assessment of its risk-mitigation efforts for the Hanford waste treatment project as a result of the lawsuit concerning its waste treatment and disposal strategy. We did not evaluate DOE's litigation strategy.

We conducted our review from July 2003 through May 2004 in accordance with generally accepted government auditing standards.

Analysis of DOE's Cost-Saving Estimates

DOE has estimated that by accelerating cleanup of the high-level tank wastes at its Hanford Site, it can realize savings of as much as $20 billion by shortening the time frame for completing the project by almost 20 years and better aligning waste treatment and disposal approaches with the wastes' characteristics. Our review of DOE's savings estimate suggests that the estimate is overstated and misleading. The savings estimate is overstated because DOE did not consider the time value of money or properly adjust its estimates for inflation. The savings estimate is misleading because DOE used point estimates of costs that do not consider uncertainties inherent in this type of analysis, such as projecting costs for new or untested technologies or treatment options.

- *DOE's savings estimate is overstated because it did not consider the time value of money or properly adjust for inflation.* According to standard economic analysis and guidance developed by the Office of Management and Budget (OMB),[1] cost-comparison analyses should be based on life-cycle costs of competing alternatives with future costs discounted to present values, that is, adjusted both for inflation and the time value of money. According to this guidance, DOE should have first converted the annual expected costs of cleanup for both its baseline estimate and its accelerated approach estimate to their present value in 2003 and then compared the two present-value costs. In contrast, DOE's comparison of its baseline estimate with its accelerated estimate is based on values that are simply the sum of current dollar values of future costs. As a result, DOE's methodology does not reflect an accurate comparison of its baseline estimate with the accelerated approach estimate.

- *DOE's cost-saving estimate is misleading because it did not consider uncertainties inherent in DOE's waste cleanup program.* According to OMB guidance, agencies should attempt to characterize the nature and source of uncertainty associated with their data and report data uncertainties or the full range of values within which their estimates can fall. Uncertainties inherent in DOE's tank waste program include the future costs of new technologies and waste treatment options that are not fully tested and the overall duration of waste treatment activities. For example, DOE expects to reduce treatment costs significantly based on a technology called "bulk vitrification." The life-cycle cost estimate

[1]OMB Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (Washington, D.C.: Oct. 29, 1992).

developed for this technology, however, is preconceptual and will likely increase as this technology is developed, according to the bulk vitrification project manager. DOE has not developed an estimate of the range of possible costs for this technology and has not reflected this uncertainty in its cost-savings estimate.

To correct for DOE's methodological errors and illustrate their potentially significant effect, we obtained DOE's available annual cost and budget estimates for the project, but we considered the effects of the time value of money and inflation. In addition, although we were not able to adjust DOE's cost-savings estimate to demonstrate the effects of all uncertainties, for illustrative purposes we included the uncertainty associated with changes in interest rates. Rather than using one interest rate in the savings estimate, as DOE did, we included in our analysis a range of interest rates, which resulted in a range of possible project costs.[2]

Table 3 summarizes the differences in the cost-savings estimate between DOE's approach and our present-value analysis that reflects the uncertainty associated with future interest rates. Our analysis shows that the estimated savings from DOE's accelerated approach could range from $10 billion to $13 billion, with a mean value of $12 billion. In other words, the estimated cost savings DOE can expect from implementing its accelerated cleanup approach is about $12 billion, or about half of the projected savings the department has reported.

[2]We assumed that real (adjusted for inflation) annual interest rates would range from a minimum of 2.92 percent to 5.39 percent with the likeliest value of 3.84 percent. We used an Excel spreadsheet and a commercially available risk analysis program, called "Crystal Ball," to perform this analysis. This program randomly selects values for the interest rate from the given range and uses each value in the spreadsheet to calculate the savings.

Table 3: GAO Analysis of DOE's Cost-Savings Estimate for the Hanford Tank Waste Treatment Project

Dollars in billions

Description of estimates	Baseline estimate	Accelerated estimate	Estimated savings
DOE's life-cycle cost estimates for fiscal year 2001 baseline and 2003 accelerated approach (current dollars)	$56[a]	$27[b]	$20[c]
GAO's present-value analysis results for the DOE baseline and accelerated estimate (constant 2003 dollars)	$26[d]	$14[d]	$12[d]
Range of present-value analysis results (constant 2003 dollars)	$23–$29[e]	$13–$15[e]	$10–$13[e]

Source: GAO analysis of DOE data.

[a]According to the project's budget team leader, this figure is the approved 2001 baseline (including adjustments).

[b]This figure is Hanford's approved 2003 accelerated estimate.

[c]The actual difference is $29 billion. Since implementation of its accelerated initiative, DOE has stated publicly that it expects to achieve savings of $20 billion.

[d]These figures represent the means of our present-value analysis.

[e]Values represent the maximum and minimum of the range of estimated values from the present-value analysis when uncertainties are incorporated.

Comments from the Department of Energy

Department of Energy
Washington, DC 20585
May 25, 2004

Ms. Robin M. Nazzaro
Director, Natural Resources and Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Nazzaro:

We have reviewed your draft report entitled *Absence of Key Management Reforms on Hanford's Cleanup Project Adds to Challenges of Achieving Cost and Schedule Goals* (GAO-04-611). I appreciate the opportunity to comment on this report and our specific comments are enclosed.

Your report contains two recommendations for executive action. The first recommendation, which I accept, concerns the Department of Energy's (DOE) project management initiative when acquiring complex waste treatment plants. Specifically, you recommend avoiding approaches where design, construction, and technology development are performed concurrently. DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*, which the Office of Environmental Management (EM) program now follows, addresses the concerns you raised in your report.

The second recommendation involves providing a plan to Congress detailing cost and schedule impacts to the EM program if most of the tank waste must be disposed in the repository. A recent court ruling raises legal uncertainty that the DOE can manage some of its spent nuclear fuel reprocessing (i.e., tank) wastes, as non-high-level waste. You state that the DOE has not performed a formal risk assessment and does not have an integrated strategy to deal with this possibility. While we have not performed a formal risk assessment, the DOE does have an integrated strategy involving legal and legislative actions.

The DOE has appealed this ruling and, as the U.S. General Accounting Office (GAO) recommended, has been in dialogue with both state governments in which DOE's tank wastes are located, and applicable congressional delegations to develop language that provides for appropriate authorities for making determinations of how the waste should be disposed, that preserve DOE's Atomic Energy Act authorities and the states' environmental regulatory authorities. The results of these initiatives are likely to define the legal landscape that in turn will shape DOE's options for disposal of this waste. Since such a revision would require significant time, effort, and considerably increased costs, we believe it prudent to wait until we know the outcome of these initiatives. Thus, while DOE agrees with GAO that it should continue to develop more complete information about the potential costs that disposal of most or all of the tank waste and the

tanks themselves at a repository would entail, we believe that the purpose should be to give Congress a better sense of the magnitude of what would be involved, and not necessarily to provide a complete revised strategy, which DOE believes should at least await completion of the appellate process.

If you have any further questions, please call me at (202) 586-7709 or Mr. Eugene C. Schmitt, Deputy Assistant Secretary for Environmental Cleanup and Acceleration, at (202) 586-0755.

Sincerely,

Jessie Hill Roberson
Assistant Secretary for
Environmental Management

Enclosure

GAO Contacts and Staff Acknowledgments

GAO Contacts

Robin M. Nazzaro (202) 512-3841
William R. Swick (206) 287-4800

Staff Acknowledgments

In addition to those individuals named above, Chris Abraham, Ellen Chu, Bob Crystal, Doreen Eng, Doreen Feldman, George Hinman, Nancy Kintner-Meyer, Mehrzad Nadji, Tom Perry, Emily Pickrell, and Stan Stenersen made key contributions to this report.

GAO's Mission

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

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through the Internet. GAO's Web site (www.gao.gov) contains abstracts and full-text files of current reports and testimony and an expanding archive of older products. The Web site features a search engine to help you locate documents using key words and phrases. You can print these documents in their entirety, including charts and other graphics.

Each day, GAO issues a list of newly released reports, testimony, and correspondence. GAO posts this list, known as "Today's Reports," on its Web site daily. The list contains links to the full-text document files. To have GAO e-mail this list to you every afternoon, go to www.gao.gov and select "Subscribe to e-mail alerts" under the "Order GAO Products" heading.

Order by Mail or Phone

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

U.S. General Accounting Office
441 G Street NW, Room LM
Washington, D.C. 20548

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

To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

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

Public Affairs

Jeff Nelligan, Managing Director, NelliganJ@gao.gov (202) 512-4800
U.S. General Accounting Office, 441 G Street NW, Room 7149
Washington, D.C. 20548

United States
General Accounting Office
Washington, D.C. 20548-0001

Official Business
Penalty for Private Use $300

Address Service Requested

Presorted Standard
Postage & Fees Paid
GAO
Permit No. GI00