

June 2007

NUCLEAR WASTE

DOE Should Reassess Whether the Bulk Vitrification Demonstration Project at Its Hanford Site Is Still Needed to Treat Radioactive Waste





Highlights of [GAO-07-762](#), a report to congressional committees

Why GAO Did This Study

The Department of Energy (DOE) is demonstrating a technology called bulk vitrification, in parallel with the Hanford waste treatment plant, to treat a portion of the radioactive waste stored in 177 tanks at its Hanford site in southeastern Washington state. DOE faces technical and management problems that have affected the original objectives to justify demonstrating the bulk vitrification technology.

This report discusses the extent to which DOE (1) has managed the bulk vitrification demonstration project consistent with DOE management guidance and (2) continues to need a supplemental technology, such as bulk vitrification, to treat a portion of the low-activity tank waste. To assess DOE's management of the project, GAO reviewed reports by DOE and others and discussed the project with DOE and contractor officials.

What GAO Recommends

GAO recommends that DOE (1) reassess the need for a supplemental technology and the costs and benefits of bulk vitrification compared with other viable technologies and (2) report to Congress the results of the reassessment. In addition, Congress should consider withholding additional funding for the project until DOE does so. DOE disagreed with several of the report's findings but did not comment on GAO's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-07-762.

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

NUCLEAR WASTE

DOE Should Reassess Whether the Bulk Vitrification Demonstration Project at Its Hanford Site Is Still Needed to Treat Radioactive Waste

What GAO Found

DOE did not follow its management requirements during the first 2 years of the demonstration project in an effort to accelerate tank waste cleanup. This decision contributed to a nearly fourfold increase in estimated costs from \$62 million to \$230 million and a 6-year delay on the project. DOE did not conduct key internal and external reviews and did not fully develop or update key project planning documents as required. Without these management tools, DOE initially overlooked a number of technical and safety problems facing the project, such as uncertainties about the quality of the glass formed using the bulk vitrification technology and inadequate systems to shield radioactive material from workers and the environment. In late 2005, largely because of these problems, DOE began taking steps to implement its management requirements on the project.

DOE's need for a supplemental technology to treat a portion of the low-activity tank waste at Hanford is no longer clear, but DOE does not plan to reassess the need for the project before completing the demonstration. Originally, DOE justified the bulk vitrification project as a relatively low-cost, rapidly deployable supplemental technology to assist the department to complete tank waste treatment at Hanford by 2028. However, none of the key components to this justification remains today (see table). First, the price of a full-scale bulk vitrification facility has risen to \$3 billion or more, about the same cost as adding a second low-activity waste treatment facility to the waste treatment plant. Second, the technology is no longer rapidly deployable because, as discussed above, the project faces at least a 6-year delay. Finally, it is now apparent that completing tank waste treatment at Hanford by 2028 is not possible under any reasonable scenario and that the waste treatment plant must operate for longer than DOE previously planned. This is significant since longer operating periods may reduce the need for a supplemental technology. Given the plant's estimated treatment capacity, more of the low-activity waste could be treated in the waste treatment plant facilities. Although DOE's management guidance specifies that when conditions have significantly changed DOE should reassess the mission need of a project, DOE does not intend to conduct this reassessment because DOE officials said they want more information about the technology. Proceeding with the demonstration project before reaffirming the need for the project increases the risk that DOE will spend an additional \$137 million or more to develop a technology that may not be needed.

Original Objectives and Current Conditions of DOE's Demonstration Project

| Original objective | Current condition |
|---|---|
| Rapid demonstration of the technology by 2006 | Not achievable; current estimated completion by 2012 or later |
| Rapid deployment of full-scale facility by 2011 | Not achievable; current estimated deployment by 2019 |
| Full-scale facility costing about \$1.3 billion | Not achievable; current estimated life-cycle cost is \$3 billion or more |
| Complete waste treatment by 2028 | Not achievable; current estimated completion date unclear but ranges from 2039-2074 |

Source: DOE.

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Abbreviations

| | |
|------|------------------------------------|
| AMEC | AMEC Earth and Environmental, Inc. |
| DOE | Department of Energy |
| EPA | Environmental Protection Agency |

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United States Government Accountability Office
Washington, DC 20548

June 12, 2007

The Honorable Byron L. Dorgan
Chairman
The Honorable Pete V. Domenici
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Peter J. Visclosky
Chairman
The Honorable David L. Hobson
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations
House of Representatives

The Department of Energy (DOE) is responsible for one of the world's largest environmental cleanup programs—the treatment and disposal of nuclear waste created as a by-product of producing nuclear weapons. Decades of nuclear weapons production have left a legacy of chemical, hazardous, and radioactive wastes to be cleaned up at DOE sites across the country. One of the most contaminated nuclear waste sites in North America is DOE's Hanford site located along the Columbia River in southeastern Washington state. This site occupies 586 square miles upriver from the cities of Richland, Pasco, and Kennewick, with a combined regional population of over 200,000. Since 1989, DOE has spent more than \$10 billion to manage about 56 million gallons of high-level radioactive and hazardous waste at the site and explore ways to treat and dispose of it. However, to date, none of the tank waste at Hanford has been treated for final disposal. Over the years, including testimony before this subcommittee in April 2006, we have criticized DOE's management of Hanford's tank waste and its efforts to design and build facilities that are capable of treating the waste.¹

¹GAO, *Hanford Waste Treatment Plant: Contractor and DOE Management Problems Have Led to Higher Costs, Construction Delays, and Safety Concerns*, [GAO-06-602T](#) (Washington, D.C.: Apr. 6, 2006).

DOE currently manages this waste in 177 large, aging, underground storage tanks. The waste contains high-level radioactive constituents (less than 10 percent by volume) to be stabilized on the Hanford site and then sent to a geologic repository for permanent disposal. DOE plans to stabilize the low-activity radioactive constituents (more than 90 percent by volume) and dispose of it on-site in near-surface burial facilities. DOE is required to complete treatment of all of the Hanford tank waste by 2028, as part of the Tri-Party Agreement between DOE, the Environmental Protection Agency (EPA), and the Washington State Department of Ecology.² DOE manages its projects under a project management order and implementing guidance³ that require a formal set of internal and external reviews and approvals during the planning and execution of a project to help ensure work is completed on schedule, within budget, and according to mission needs.

To address the tank waste, DOE is constructing the Hanford Waste Treatment and Immobilization Plant (waste treatment plant), a large complex of treatment and support facilities.⁴ DOE's initial plan for the waste treatment plant was a phased approach to first demonstrate treatment technologies and then add capacity by constructing additional treatment facilities within the plant. DOE initially expected that treating all of the tank waste would take until about 2046, but during the design and early construction years of the plant the department began to explore ways to accelerate the cleanup and treat all of the waste by 2028, as required by the Tri-Party Agreement. DOE's contractor subsequently modified the plant design to expand the capacity or "throughput" of the facilities under construction by, for example, requiring larger waste treatment equipment. Based on those changes, DOE expected that the

²The Tri-Party Agreement is a legally binding agreement that incorporates the requirements of federal environmental laws and guides the process under which DOE will address the wastes and environmental contamination at the Hanford site.

³DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*, issued Oct. 13, 2000. DOE issued a revised order as DOE Order 413.3A on July 28, 2006.

⁴The waste treatment plant includes three primary waste processing facilities—the pretreatment facility, which will receive waste from Hanford's underground tanks and separate it into its high-level and low-activity waste components; the high-level waste facility that will immobilize high-level waste for off-site disposal through a process known as vitrification, which mixes nuclear waste with molten glass; and the low-activity waste facility that will immobilize the low-activity waste for on-site disposal. In addition, a large analytical laboratory and more than 20 other buildings will support waste treatment activities.

waste treatment plant would be able to treat all of the high-level waste and about half of the low-activity waste by 2028.

To treat the other half of the low-activity waste without adding to the cost of the waste treatment plant that was already under construction, DOE began exploring options to develop a supplemental technology that would be low cost, capable of being rapidly developed, and could help complete all waste treatment by 2028. In 2003, after examining a variety of alternatives, DOE decided to develop a separate supplemental technology called bulk vitrification to see if it had the potential to treat the remaining low-activity tank waste.⁵ Bulk vitrification involves drying and placing low-activity waste in large steel containers, mixing the waste with other feed material—such as soil and other glass-forming materials—heating it with electrical currents inside the containers until the mixed materials melt, and then letting them cool into a solid, glass material. The waste is then permanently stored on-site in those containers.⁶ DOE selected the bulk vitrification technology because the department believed it would add flexibility to DOE's tank waste treatment effort and be less costly, relatively rapid and straightforward to develop, and likely to meet a more aggressive schedule compared with other options. In addition, the bulk vitrification technology was acceptable to federal and state environmental agencies because it would stabilize the waste in glass that would meet or exceed the disposal standards agreed to in the Tri-Party Agreement. A contract was awarded in June 2004 to design and build a pilot plant that would both test and demonstrate the viability of the technology and treat about 200,000 gallons of tank waste within 2 years.

By 2006, DOE planned to compare bulk vitrification with other viable alternatives, and, if selected, design, build, and then beginning in 2011, operate a full-scale bulk vitrification facility in parallel with the waste treatment plant. DOE initially estimated the Demonstration Bulk

⁵To examine the alternatives, DOE conducted a review that included an assessment of studies and a series of workshops with experts from national laboratories, industry, and academia. The experts grouped the technologies into potential treatment approaches involving various methods of preparing, treating, and solidifying the waste for permanent on-site storage. In all, DOE compared about 10 available technical approaches for treating Hanford's low-activity waste.

⁶In contrast to a bulk vitrification facility, the low-activity waste vitrification facility for the waste treatment plant would consist of a vitrification technology that involves feeding the waste and other feed material into a device, called a melter, where the waste is heated to a molten state, then poured into stainless steel canisters, where it is allowed to cool into a solid form and permanently stored on-site.

Vitrification System (demonstration project) would cost \$62 million. However, since awarding the contract in 2004, the project's estimated cost has increased from \$62 million to \$230 million, and its scheduled completion date has been extended from 2006 to 2012.⁷ In mid-2005, DOE suspended construction activities and decided not to request continued project funding from Congress in fiscal years 2007 and 2008 until it had a better understanding of the project's scope and technical uncertainties. To date, DOE has spent about \$93 million on the demonstration project. If bulk vitrification is selected as the supplemental technology for treating a portion of Hanford's tank waste, DOE's plans include eventually building and operating two full-scale bulk vitrification facilities located near the underground storage tanks in the east and west areas of the Hanford site.

Because of the significant technical and management problems DOE is facing on the waste treatment plant project and the important role DOE assigned to the bulk vitrification demonstration in achieving the overall objectives for stabilizing the tank waste at Hanford, you asked us to review the status of the demonstration project. On October 12, 2006, we briefed your staff on the preliminary results of our review. To respond to your remaining concerns, this report addresses the extent to which DOE (1) has managed the bulk vitrification demonstration project consistent with departmental management guidance and (2) continues to need a supplemental technology, such as bulk vitrification, to treat a portion of the low-activity tank waste.

To determine how the bulk vitrification demonstration has been managed, we compared project management practices with project management guidance and documented any differences. We also documented the steps the department has taken to improve management of the demonstration. To determine the extent to which DOE continues to need a supplemental technology, we reviewed external technical studies and cost reviews on the project and discussed with DOE and contractor officials the steps they have taken to resolve problems experienced to date. In addition, since the purpose of the bulk vitrification technology is to supplement the capacity of the Hanford waste treatment plant, we spoke with DOE's Office of River Protection and contractor officials to determine the extent to which the waste treatment plant's cost, schedule, and technical changes may affect

⁷The initial contract price of \$62 million included a smaller work scope involving a modular, mobile waste treatment facility, while the \$230 million contract price involves a larger, stationary treatment facility that includes the capacity to accept waste retrieved from an underground storage tank.

the bulk vitrification demonstration project. A more detailed description of our scope and methodology is provided in appendix I. We performed our work between June 2006 and May 2007 in accordance with generally accepted government auditing standards.

Results in Brief

DOE did not follow departmental project management requirements during the first 2 years of the demonstration in an effort to accelerate the tank waste cleanup, which contributed to a nearly fourfold increase in estimated project costs from \$62 million to \$230 million, and a 6-year delay on the project. Specifically, early in the demonstration, DOE did not conduct key internal and external reviews that would have evaluated the project's design, procurement, and construction management approach and that were designed to identify potential problems and address them before starting construction. In addition, DOE did not fully develop or update key project planning documents, such as a project execution plan, an acquisition plan, and a validated project cost baseline. Without these management tools, DOE initially overlooked a number of technical and safety problems facing the demonstration project, such as uncertainties about the quality of the glass formed using the bulk vitrification technology and inadequate systems to shield and confine radioactive material from workers and the environment. These problems contributed to an increase in the project's estimated cost and a delay in the estimated completion date. In late 2005, largely because of these problems, DOE determined that the project should be managed in accordance with departmental guidance, including focusing on completing the facility design before continuing construction activities, updating project execution and acquisition plans, and commissioning two independent reviews to assess the viability of the project's approach, as well as its cost and schedule estimates.

DOE's need for a supplemental technology to treat a portion of the low-activity tank waste at Hanford is no longer clear, but DOE does not plan to reassess the need for the bulk vitrification project before continuing with the demonstration. In the 4 years since DOE selected the bulk vitrification technology for further development, conditions have changed. Originally, DOE justified bulk vitrification as a relatively low-cost, supplemental technology that could be rapidly deployed to complement the waste treatment plant and treat all of the remaining tank waste at Hanford by 2028. However, none of the key components to this justification remains today. First, technical and safety problems during the project have not only led to higher project costs, but have also led DOE to make changes to the facility design. These problems have also resulted in increases to the

estimated life-cycle cost of future full-scale bulk vitrification facilities from about \$1.3 billion to \$3 billion. This is about the same cost as another alternative DOE previously considered—adding a second low-activity waste treatment facility to the waste treatment plant. Second, the technology is no longer rapidly deployable because, as discussed above, the project faces at least a 6-year delay. DOE now estimates that the bulk vitrification demonstration project would not be completed until 2012 and that the full-scale bulk vitrification facilities would not be fully available until late 2019. Finally, it is now apparent that completing waste treatment at Hanford by 2028 is not possible under any reasonable scenario and that the waste treatment plant must operate for longer than DOE previously planned. This is significant since longer operating periods may reduce the need for a supplemental technology. Given the plant's estimated treatment capacity, more of the low-activity waste could be treated in the waste treatment plant facilities.

DOE's project management guidance specifies that when conditions have significantly changed, the department should reassess the mission need, as well as the benefits and appropriateness of continuing with a project. Despite this fact, DOE plans to renew requests for project funding in fiscal year 2009 but does not intend to reassess the overall need for the project until much later. DOE project officials acknowledged that the need for bulk vitrification may be less compelling than when initially selected, but they said that developing more information about bulk vitrification would provide additional treatment flexibility that may have value in the future. As part of the effort to develop more information, DOE is in the process of comparing various combinations of treatment options for completing tank waste treatment at Hanford. The purpose of this comparison is to support near-term tank waste funding decisions rather than assess bulk vitrification or the need for a supplemental technology. However, proceeding with the demonstration project before reaffirming the need for a supplemental technology, or reassessing the need for the bulk vitrification project, increases the risk that DOE will spend an additional \$137 million or more to develop a technology that may not be needed or is no longer the best option for treating Hanford's low-activity tank waste.

We are recommending that, before continuing with the bulk vitrification demonstration project, the Secretary of Energy direct the Assistant Secretary for Environmental Management to (1) reassess the continuing need for a supplemental technology to treat a portion of Hanford's low-activity tank waste; (2) if a reassessment shows that a supplemental technology is still needed, reassess the relative costs and benefits of demonstrating and deploying bulk vitrification compared with other

available technologies; and (3) report to Congress on the results of the reassessment before requesting additional funding for the bulk vitrification demonstration. If DOE does not reassess the bulk vitrification project before requesting additional funding for the project, we are recommending that Congress consider withholding the additional funding until DOE implements these recommendations.

DOE commented on a draft of the report and disagreed with the report's assertions that the bulk vitrification project did not follow the department's project management requirements. In addition, DOE commented that the project has been subject to multiple, formal independent project management, technical, and safety reviews. Furthermore, DOE stated that it is already performing an assessment of options to complete the cleanup of Hanford's waste tanks and that bulk vitrification is one of several supplemental treatment technologies being evaluated. We disagree with DOE's comment that the bulk vitrification project followed DOE's project management requirements. Documents that DOE provided during our review indicate it was not until September 2005—after the project had experienced numerous problems and significant cost and schedule increases—that DOE decided the demonstration project would be subject to the department's project management order. Regarding DOE's assessment of options to complete tank waste cleanup, we do not believe it constitutes the reassessment of the need for a supplemental technology or the relative costs and benefits of demonstrating and deploying bulk vitrification compared with other viable technologies that our report recommends. Although DOE did not comment on our recommendations, we believe that implementing them will enhance the available data on the bulk vitrification project and improve the basis for future DOE decisions.

Background

DOE carries out its waste cleanup program at Hanford under the direction of the Assistant Secretary for Environmental Management and in consultation with a variety of stakeholders. EPA and the Washington State Department of Ecology provide regulatory oversight of cleanup activities at the site. The Defense Nuclear Facilities Safety Board (Safety Board) also oversees DOE's operations.⁸ Other stakeholders involved in the

⁸The Safety Board was created by Congress in 1988 to provide an independent assessment of safety conditions and operations at defense nuclear facilities, including DOE's Hanford site. See 42 U.S.C. §§ 2286-2286i.

Hanford cleanup project include county and local governmental agencies, Native American tribes, advisory groups, and citizen groups. These stakeholders advocate their views through various processes, including site-specific advisory boards. DOE manages the tank waste at Hanford through its Office of River Protection, which Congress directed DOE to establish in 1998. The office has a staff of about 110 DOE employees and a fiscal year 2007 budget of about \$1 billion. It manages Hanford's tank waste through two main contracts: a tank farm operations contract with CH2M Hill Hanford Group, Inc., to maintain safe storage of the waste in underground tanks and to prepare it for retrieval, and a construction contract with Bechtel National, Inc., to design, construct, and commission the waste treatment plant. DOE's tank farm contractor, CH2M HILL Hanford Group, Inc., awarded a subcontract to AMEC Earth and Environmental, Inc. (AMEC), to begin testing the bulk vitrification technology.

Management Weaknesses during the Bulk Vitrification Demonstration Project Contributed to Technical Problems, Cost Increases, and Schedule Delays

As part of the effort to accelerate the tank waste cleanup at the Hanford site, DOE site officials decided not to follow a number of project management requirements on the bulk vitrification demonstration project. Without the management tools that these requirements provide, DOE initially overlooked a number of technical and safety problems facing the demonstration, which contributed to an increase in the project's estimated cost and a delay in the estimated completion date. In late 2005, largely because of the technical and safety problems, DOE determined that the project should be managed in accordance with departmental requirements and is currently in the process of implementing these requirements.

DOE Did Not Follow Project Management Requirements during the First 2 Years of the Demonstration

DOE's project management requirements outlined in the DOE order specify that a number of steps be taken throughout the development of a project. These requirements apply to all capital projects having a total cost of at least \$20 million and are intended to ensure that projects are effectively delivered on schedule and within budget and that both DOE and its contractors are held accountable. According to the Secretary of Energy, the purpose of the requirements is to provide for a documented decision-making process that fosters a disciplined project planning approach and a method for measuring progress toward defined goals. As such, the order includes a requirement to follow a strict set of decision points outlining specific actions that DOE must take before beginning the

construction and operations of a new facility. Some of these specific actions include conducting various internal and external reviews, developing key project documents, such as an acquisition strategy and a project execution plan, and developing and validating a cost and schedule estimate.⁹ These requirements are applicable to both DOE and its contractors on the project.

However, during the first 2 years of the bulk vitrification project, DOE did not follow its management requirements. In an effort to expedite cleanup activities in 2003, as part of DOE's accelerated cleanup initiative, DOE officials at the Hanford site determined that activities connected to Hanford's tank waste cleanup effort would not be subject to the project definition requirements of the DOE order. Specifically, DOE made two key determinations to justify its decision to accelerate the project. First, DOE reasoned that since the tank farm cleanup effort, as a whole, did not technically meet the definition of a project—work that has a defined start and end point and that creates a “product, facility, or system”—related activities would not be subject to DOE's strict project management requirements. Based on that decision, in 2004, DOE officials at Hanford determined that the bulk vitrification demonstration project, which was managed as part of DOE's tank farm activities, would also not be subject to DOE's project management requirements. However, this determination was not consistent with DOE's requirements since the demonstration project is expected to have a start and end point and result in a facility. Second, DOE officials further justified the decision to not apply the project management requirements by asserting that the demonstration project was a minor research and development effort. However, specific language in the DOE order states that “technology development activities,” such as the bulk vitrification project, should be subject to the requirements in the order.

As a result of DOE's decision not to apply some of the requirements of its order during the early stages of the demonstration project, DOE and its contractor did not take a number of key project management steps called for in the order. For example, DOE is required to conduct internal and external reviews to evaluate a project's mission need and cost estimate in

⁹According to the DOE order, an “acquisition strategy” is a document describing the high-level business and technical management approach that includes a master schedule, along with details about planning, organizing, and controlling a project; a “project execution plan” is the core document for managing a project and includes policies and procedures to be followed and how the project is to be accomplished.

the development of a project. However, DOE did not conduct these reviews that could have helped identify potential problems during the first 2 years of the bulk vitrification demonstration. Similarly, DOE's guidance requires project managers and DOE contractors to develop and update key project planning documents, such as a project execution plan and an acquisition strategy. While both of these documents were created in early 2004, neither was updated when the contractor was awarded the contract for the demonstration several months later. Instead, the contract called for a fast-track, design-build approach where design, construction, and technology development occur simultaneously. This approach increases the risk of encountering problems that can adversely affect a project's cost and schedule.¹⁰ Finally, the project management order requires DOE to develop, validate, and maintain an updated cost and schedule baseline for its projects and to notify the proper DOE headquarters officials when significant changes to these estimates occur. However, DOE did not develop, and still does not have, a validated cost and schedule baseline for the project about 3 years after awarding the contract. DOE now plans to follow the management order by developing and validating a cost and schedule estimate for the demonstration project in early fiscal year 2008.

The Demonstration Project Faced a Number of Technical and Safety Problems Resulting in Cost Increases and Schedule Delays

The bulk vitrification technology posed a number of technical and safety problems very early on in the development of the project. Even before the contract was awarded in 2004, DOE's contractor was aware of potential problems that could affect the demonstration. For example, during initial testing of the technology in 2003, which involved melting simulated waste, not all of the simulated waste—intended to mimic the properties of hazardous materials, such as technetium 99—was retained in the glass. In subsequent large-scale tests, some of the simulated waste collected near the surface of the container and began leaking out through the joints in the container. Similarly, testing in 2003 indicated that the contractor was aware of potentially dangerous emissions during operations of the facility that could have safety implications to demonstration workers. In August 2005, the Safety Board reported that the facility, as designed, would not adequately contain radioactive and hazardous emissions during and after melting operations. The Safety Board pointed out that the facility design did not comply with DOE's own facility safety requirements and requested that DOE resolve these weaknesses.

¹⁰Since 1992, we have reported frequently on the problems and risks of this approach to managing projects. See, for example, [GAO-06-602T](#).

These technical and safety problems contributed to an increase in the demonstration's estimated cost and a delay in the projected completion date. One month after awarding the \$62 million contract for the demonstration, the contractor informed DOE that to address these issues, the cost estimate had nearly doubled to an estimated \$102 million. The cost estimate has since risen to about \$230 million—nearly a fourfold increase from the initial contract price—as DOE and its contractors have taken steps to address these problems. These steps included upgrading facility designs, such as changes to accommodate more robust safety systems than had originally been anticipated; additional testing; and other scope changes, such as adding the cost to accept waste retrieved from one of Hanford's tanks for testing. In addition, these changes caused the initial estimated completion date for the demonstration to slip from 2006 to the current estimate of 2012.

DOE's decision not to follow its project management requirements likely contributed to these problems. Without the management tools called for in DOE's requirements, such as updated timely reviews, project documents, and a validated cost and schedule baseline, these problems were not brought to the attention of DOE headquarters. For example, even though the costs increased significantly during the first few months of the project, without a validated baseline for the project, DOE's contractor did not file an official baseline change request that would have alerted DOE management of the cost increases. Similarly, because DOE and its contractor did not follow the strict set of approvals required by DOE's order at key decision points, there was no way for DOE to formally reassess the risks and mission needs as the project became more expensive and complex. According to a review of the project conducted in September 2005, having these key management tools in place when the project began would have provided DOE with an opportunity to identify and address these problems.¹¹ Without these tools, however, DOE was not fully informed, and the contractor was allowed to continue at an accelerated pace. Despite the problems facing the project, construction began on the demonstration facility in January 2005, with detailed facility design only about 30 percent complete.

¹¹*Demonstration Bulk Vitrification System Independent Review Report*, Longenecker and Associates, September 2005.

DOE Began Following Management Requirements in the Third Year of the Demonstration

In 2005, facing numerous problems, DOE halted construction on the project and determined that it should be managed in accordance with departmental project management requirements. In May 2005, 4 months after construction had begun, DOE's contractor began slowing down its activities related to the demonstration in order to assess the reasons behind the cost increases and schedule delays. In addition, in August 2005, the Secretary of Energy instructed all program offices to follow DOE's order "scrupulously, without exception." As a result, in September 2005, DOE officials at Hanford instructed the contractor to more rigorously follow project management requirements, including focusing on completing facility design before continuing construction activities, updating project execution and acquisition plans, and commissioning two independent reviews to assess the demonstration's technical approach and cost and schedule estimates. DOE decided not to request funding for the project in fiscal years 2007 and 2008 while the problems are being resolved.

DOE is currently in the process of implementing a number of its project management requirements to address the problems facing the project and to better control costs. Because the project was at an advanced stage of design development when DOE chose to begin following its management order, DOE has had to implement some of the requirements retroactively. For example, DOE updated the project initiation documents, such as the project execution plan and the mission needs statement, and obtained internal approvals for those documents even though the project was past the initiation stage. DOE also commissioned external independent reviews called for in its order, including two external technical reviews of the demonstration,¹² as well as a management review of the project. Finally, DOE is currently in the process of developing and validating a cost and schedule baseline for the demonstration and plans to submit the entire project package for another review by the department's Office of Engineering and Construction Management in early fiscal year 2008, as required by DOE's order.

¹²One of these reviews of the project identified 19 technical issues that could result in a failure of the bulk vitrification demonstration to meet performance requirements unless addressed before operational startup, and 26 areas of concern that could result in a change to facility design or require additional testing to determine if the design is adequate. See *A Comprehensive Technical Review of the Demonstration Bulk Vitrification System*, Technical Assessment Conducted by an Independent and External Team of Experts, Volume 1, chartered by CH2M Hill Hanford Group, Inc. (Richland, Wash.: Sept. 28, 2006).

The Extent to Which the Bulk Vitrification Demonstration Is Still Needed Is Unclear; However, DOE Does Not Plan to Reassess Its Need Before Continuing with the Demonstration

The extent to which DOE continues to need a supplemental technology to treat a portion of the low-activity tank waste at Hanford is unclear. In the years since DOE selected bulk vitrification as the preferred technology, significant changes to the objectives that originally existed have raised questions about whether bulk vitrification is the most viable option for treating a portion of Hanford’s low-activity tank waste. Despite these questions, DOE does not plan to reassess the project before continuing with the demonstration and has not developed an acquisition strategy that clearly shows how the bulk vitrification and waste treatment plant projects will be integrated to control costs and meet tank waste cleanup requirements.

The Original Objectives That Justified Developing the Bulk Vitrification Technology Are No Longer Achievable

The original objectives DOE used to justify demonstrating and deploying the bulk vitrification technology are no longer achievable. Table 1 compares DOE’s original objectives for demonstrating and deploying the bulk vitrification technology with the current conditions.

Table 1: Original Objectives for Demonstrating and Deploying Bulk Vitrification Technology Compared with Current Conditions

| Original objectives | Current conditions |
|--|---|
| Rapid demonstration of the technology by 2006 | Not achievable; current estimated completion by 2012 or later |
| Rapid deployment of full-scale facility by 2011 | Not achievable; current estimated deployment by 2019 |
| Full-scale facility costing about \$1.3 billion ^a | Not achievable; current estimated life-cycle cost is \$3 billion or more ^a |
| Complete waste treatment by 2028 | Not achievable; current estimated completion date unclear but ranges from 2039–2074 |

Source: DOE.

^aThese figures are in constant 2006 dollars.

DOE’s goals of rapidly demonstrating and deploying bulk vitrification as a supplemental technology in conjunction with waste treatment plant operations are no longer achievable. DOE initially planned to use a fast-track, design-build approach to demonstrate bulk vitrification as the preferred supplemental technology by 2006 and have a facility fully operational by 2011 when the waste treatment plant was scheduled to begin operations. Although DOE has not been able to demonstrate and deploy the bulk vitrification technology at this aggressive pace, the

urgency to do so no longer exists because of delays with the waste treatment plant schedule, of at least 8 years, to late 2019. DOE has not yet finalized the design of the bulk vitrification demonstration, resumed construction of the demonstration facilities, or validated the project's estimated cost and schedule. Instead of demonstrating the technology by 2006, as originally planned, DOE estimated that the bulk vitrification demonstration project may be completed in 2012, or about 6 years behind schedule. Recently updated demonstration project schedules show that the demonstration may be delayed even further until early 2013. Similarly, instead of having a full-scale treatment facility operational by 2011, DOE now estimates that supplemental treatment facilities may not be fully operational until 2019, or about 8 years later than originally planned.¹³

Further, DOE expected that a supplemental technology would be less expensive than expanding the waste treatment plant, but DOE is no longer able to develop and deploy a supplemental technology at low cost. As discussed earlier, during the years that the bulk vitrification demonstration has been under way, costs increased primarily because of the technical and safety problems that have plagued the project. Such problems required DOE to make changes to the demonstration project's design and resulted in increased costs to demonstrate the bulk vitrification technology. These problems have also increased the expected cost of a full-scale operating bulk vitrification facility. DOE's life-cycle cost estimate of a full-scale bulk vitrification facility has increased from about \$1.3 billion to about \$3 billion. This is about the same cost as another alternative DOE previously evaluated in 2003—adding a second low-activity waste treatment facility to the waste treatment plant—and which DOE considered to be too expensive.¹⁴ In addition, the latest bulk vitrification life-cycle cost estimate is expected to increase further

¹³Based on the project schedule, a full-scale bulk vitrification facility in the west area of the Hanford site may be operational between 2014 and 2016. The planned facility in Hanford's east area is not scheduled to be operational until late 2019.

¹⁴Although the estimated life-cycle costs of the two facilities are about the same, their technologies are at different stages of development. A low-activity waste treatment facility, like the one currently under construction on the waste treatment plant project, represents a more mature technology than bulk vitrification because it has already been extensively demonstrated, its detailed design is more than 90 percent complete, and construction of the facility will be about 50 percent complete by the end of fiscal year 2007.

because it is based on assumptions that are no longer current¹⁵ and, according to project officials, is a conceptual estimate that is subject to change as DOE proceeds with the demonstration.

DOE also based its need for a supplemental technology, in part, on the expectation that it could accelerate the overall cleanup effort by treating about half of Hanford's low-activity waste by 2028, the legal milestone for completing tank waste treatment. However, given the recent schedule delays for both the bulk vitrification and waste treatment plant projects, this goal is no longer achievable, and it is no longer clear when, or if, a supplemental technology will be needed. DOE now estimates that the waste treatment plant may begin treating waste in late 2019, or about 8 years later than originally scheduled. A variety of factors affecting the operation of the waste treatment plant remain unresolved, including the actual capacity of the waste treatment plant facilities and the operational reliability of those facilities. Given these uncertainties, DOE has not yet defined how long waste treatment plant operations will extend. However, the length of plant operations may range from 20 to 55 years.¹⁶ This wide range reflects DOE's uncertainty about the amount of waste that the waste treatment plant can treat each year and the outcome of future negotiations DOE will have with federal and state environmental agencies to set a new time frame for completing tank waste treatment operations. This is significant as longer operating periods may reduce the need for a supplemental technology because, given the plant's estimated treatment capacity, more of the low-activity waste could be treated in waste treatment plant facilities. For example, based on the plant's maximum estimated treatment capacity, for tank waste treatment to be completed in 20 years, a supplemental technology would need to treat about half of the low-activity waste. If treatment operations extend for more than 40 years, supplemental technology may not be needed because the waste treatment plant would be able to treat all of the tank waste.

¹⁵One such assumption in the bulk vitrification life-cycle cost estimate is that tank waste treatment would be completed by 2036. In contrast, DOE's fiscal year 2008 budget request states that treatment will not be completed until 2042, or at least 6 years later than previously estimated. DOE contractor officials acknowledged that an extension to the estimate's schedule would result in increased costs, but they had not updated the estimate because the length of the operating schedule is not yet known.

¹⁶Although the fiscal year 2008 budget request indicates an operating schedule through 2042, DOE has not specifically defined the length of the waste treatment plant's operating schedule. DOE's project managers stated that the operating schedule may range from 22 to 35 years. However, an internal engineering study estimated operations may range from 20 to 55 years. We include the latter range because it reflects the full range of estimates.

DOE Does Not Plan to Reassess the Need for Continuing the Demonstration and Risks Additional Spending on a Technology That May Not Be Needed or Is Not a Viable Option for Treating Hanford's Radioactive Waste

Even though the conditions justifying the bulk vitrification demonstration have changed significantly, DOE does not plan to reassess the need for the project and plans to continue the demonstration. This decision runs contrary to DOE's project management requirements that specify that when conditions have significantly changed, the department should reassess the mission need and reexamine available alternatives as well as the benefits and appropriateness of continuing with a project. Furthermore, DOE plans to renew requests for project funding in fiscal year 2009 but does not intend to reassess the overall need for the project before proceeding. Instead, DOE decided to continue with the demonstration to obtain more information on the performance of bulk vitrification technology and compare the technology with other available alternatives by 2012 or later.

DOE project officials acknowledged that the need for bulk vitrification may be less compelling than when initially selected but said that developing more information on this technology would provide additional treatment flexibility that may have value in the future. As part of this effort to develop more information, DOE initiated an internal study in late April 2007 to compare advantages, disadvantages, and risks for various combinations of treatment options, including bulk vitrification, for successfully completing tank waste treatment at Hanford. Although this study, which is to be completed by June 30, 2007, is not a decision-making document or a comprehensive reassessment of individual technologies or the overall need for a supplemental technology, it will be used to support near-term funding decisions for the tank waste cleanup program. After completing the demonstration project in 2012 or later, DOE plans to compare the bulk vitrification technology with other viable technical alternatives, such as building a second low-activity waste facility, as required by the Tri-Party Agreement.¹⁷ However, DOE's decision to proceed with the demonstration before reassessing the need for the project increases the risk that it may spend an additional \$137 million or

¹⁷Tri-Party Agreement milestone M-62-08 required DOE to conduct a final assessment of supplemental technologies and submit a Hanford tank waste supplemental treatment technologies report by July 31, 2005. DOE missed this milestone but has agreed to perform this assessment by 2012. However, a revised milestone has not yet been formally negotiated with federal and state environmental agencies.

more¹⁸ to develop a technology that may not be needed or is no longer the most viable option for treating Hanford's low-activity tank waste.

Conclusions

Nearly 4 years after selecting bulk vitrification as the preferred technology for treating about half of Hanford's low-activity tank waste, DOE is faced with a host of technical, safety, and management uncertainties on the demonstration project, as well as more fundamental questions as to whether a supplemental waste treatment technology is still needed. Although bulk vitrification was initially viewed as a relatively low-cost technology that could be rapidly developed, demonstrated, and deployed to supplement the operations of the waste treatment plant, technical problems, rising costs, and schedule delays with the bulk vitrification demonstration project raise questions about DOE's overall strategy for addressing the waste. In light of these questions, it is unclear if pursuing the demonstration of this particular technology, instead of other technologies, is the best approach. Furthermore, because DOE now expects the waste treatment plant to operate for much longer than originally planned, the plant may be capable of treating most or all of the low-activity waste a supplemental technology was originally intended to treat. However, despite this significant uncertainty about how much waste, if any, a supplemental technology would actually need to treat, DOE is not planning to reexamine the need for bulk vitrification before proceeding with the demonstration project. In taking this approach, DOE is not following its guidelines that specify that when conditions have significantly changed, the department should reassess the benefits and appropriateness of continuing with a project. Without this reassessment, DOE risks spending an additional \$137 million or more to demonstrate a technology that may not be needed or is no longer the best available option for treating Hanford's low-activity tank waste.

Recommendations for Executive Action

In light of major changes that have occurred on both the bulk vitrification demonstration and the waste treatment plant, which may affect the demonstration's costs, schedule, and mission justification, we recommend that the Secretary of Energy direct the Assistant Secretary for Environmental Management to take the following three actions:

¹⁸To date, DOE has spent about \$93 million of the estimated \$230 million for the bulk vitrification demonstration project.

-
- Reassess the need for a supplemental technology to treat a portion of Hanford’s low-activity tank waste. The reassessment should clearly identify how a supplemental technology would complement and be integrated with waste treatment plant operations.
 - If a reassessment shows that a supplemental technology is still needed, reassess the relative costs and benefits of demonstrating and deploying bulk vitrification compared with other viable technologies, such as constructing a second low-activity waste vitrification facility.
 - Report to Congress on the results of the reassessment before requesting additional funding for the bulk vitrification project.

Matter for Congressional Consideration

Congress should consider withholding future funding for the demonstration until the department conducts and reports on a reassessment that clearly confirms the need for a supplemental technology at Hanford and bulk vitrification as a viable alternative for treating Hanford’s low-activity waste.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for its review and comment. In written comments, DOE’s Assistant Secretary for Environmental Management expressed areas of disagreement with the report’s findings but did not comment on our recommendations. DOE’s written comments on our draft report are included in appendix II. DOE also provided technical comments that we have incorporated where appropriate.

In its written comments, DOE disagreed with the draft report’s finding that the bulk vitrification project did not follow the department’s project management requirements. In addition, DOE commented that the project has been subject to multiple, formal independent project management, technical, and safety reviews. Furthermore, DOE stated that it is already performing an assessment of options to complete the cleanup of Hanford’s waste tanks and that bulk vitrification is one of several supplemental treatment technologies being evaluated.

Based on our review of available documentation, we continue to believe that the bulk vitrification project did not follow DOE’s project management requirements. Multiple documents provided by DOE during our review demonstrate that the department determined in 2003 that activities related to the Hanford tank farm cleanup effort, such as the bulk vitrification project, would not be subject to all of DOE’s project

management requirements. In fact, DOE even advised its contractor that it would not be required to follow the formal decision process outlined in DOE's project management order. Because of this decision, DOE proceeded from the initiation phase of the project to the construction phase without taking preliminary steps called for in the order, such as developing a cost and schedule baseline. DOE commented that, as early as November 2004, it recognized that additional project management oversight would be warranted as the project matured. However, documents provided to us by DOE indicate that it was not until September 2005—after the project had experienced numerous problems and significant cost and schedule increases—that DOE decided that the demonstration would, from that time forward, be subject to the requirements of its project management order.

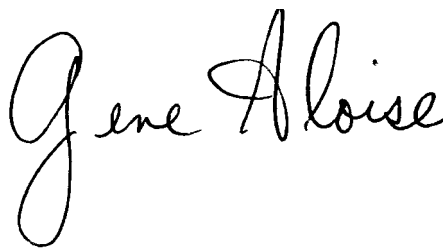
We agree with DOE that the bulk vitrification project has been subject to multiple, formal independent project management and technical and safety reviews by organizations inside and outside of the department. Our draft report discussed many of these reviews. Although these reviews have addressed important management, technical, and safety problems of the project, they are not reassessments of the need for a supplemental technology. It is also important to note that the assessment of options to complete the cleanup of Hanford's waste tanks that DOE refers to in its comments is likewise not a reassessment of the need for a supplemental technology or of bulk vitrification technology. In fact, as stated in its charter, the assessment—which is for information purposes only and is not intended as a decision-making document—assumes the continued need for a supplemental technology and development of the bulk vitrification technology. Furthermore, as our draft report noted, it is only after the bulk vitrification demonstration project is completed in 2012 or later that DOE plans to compare bulk vitrification technology with other technical alternatives. Given the scope and purpose of this assessment, we do not believe it constitutes the reassessment of the need for a supplemental technology or the relative costs and benefits of demonstrating and deploying bulk vitrification compared with other viable technologies that our draft report recommends.

While DOE agrees that the extent to which a supplemental technology would be used is imprecise, it continues to assert that there is a very high likelihood that the cleanup mission at Hanford would benefit from added capacity to treat low-activity waste. Although DOE may be correct, we are uncertain whether the department has adequately demonstrated the basis for this assertion. As our draft report discussed, the original cost and schedule conditions DOE used to justify the need for supplemental

technology have changed significantly, and the original objectives that justified developing the technology are no longer achievable. In light of these significant changes, we continue to believe that the department should reassess the mission need and benefits of continuing the project, rather than simply assuming that the need still exists. Contrary to DOE's contention, we are not recommending that the department cancel its evaluation of the bulk vitrification approach before it has data on which to base a decision. Indeed, we believe that our recommendation that DOE reassess the need for supplemental technology and the costs and benefits of bulk vitrification compared with other viable technologies would actually enhance the available data on the project and improve the basis for future DOE decisions.

We are sending copies of this report to other interested congressional committees and to the Secretary of Energy. We also will make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff has any questions on this report, please contact me at (202) 512-3841 or by e-mail at aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.

A handwritten signature in black ink that reads "Gene Aloise". The signature is written in a cursive style with a large, looped initial "G".

Gene Aloise
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

To determine how the Department of Energy (DOE) has managed the bulk vitrification demonstration project, we compared project management practices with project management guidance and documented any differences. We reviewed project planning and acquisition documents to understand the original objectives and assumptions DOE used to justify demonstrating bulk vitrification technology and for managing the demonstration project. We documented the management problems the contractor has experienced on the project from contract award to the present. We also documented the steps the department has taken to improve management of the demonstration. We discussed these steps with department and contractor officials to determine their status and to assess DOE's progress. We also discussed project oversight efforts with officials of DOE's Office of Engineering and Construction Management in Washington, D.C.

To determine the extent to which DOE continues to need a supplemental technology, we reviewed internal and external technical studies and reviews on the project and discussed with DOE and contractor officials the steps they have taken to resolve problems experienced to date. We also discussed these issues with key representatives of federal and state environmental agencies. We visited the bulk vitrification demonstration site, interviewed DOE and contractor officials, and reviewed key studies and project documents that describe how DOE and the contractor plan to conduct the demonstration. To assist in evaluating the technical aspects of the demonstration project, we obtained assistance from a 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. Since the purpose of the bulk vitrification technology is to supplement the capacity of Hanford's waste treatment plant, we spoke with DOE's Office of River Protection and contractor officials to determine the extent to which the waste treatment plant's cost, schedule, and technical changes may affect the bulk vitrification demonstration project. We also obtained documentation and discussed with these officials the life-cycle cost of a second low-activity waste facility as part of the waste treatment plant. We compared this cost with the current life-cycle cost estimate for a full-scale bulk vitrification facility.

We relied on dollar figures provided by DOE and its contractors but took various steps, such as analyzing cost estimating documents and reviewing cost estimating assumptions, reviewing budget documents, and obtaining clarifications from the officials who prepared them, to ensure that the data were sufficiently reliable for purposes of this report. We performed our

work between June 2006 and May 2007 in accordance with generally accepted government auditing standards.

Appendix II: Comments from the Department of Energy



Department of Energy

Washington, DC 20585

MAY 1 8 2007

Mr. Gene Aloise
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, D.C. 20548

Dear Mr. Aloise:

We have reviewed your draft report entitled, "*Nuclear Waste: DOE Should Reassess Whether the Bulk Vitrification Project at Its Hanford Site is Still Needed to Treat Radioactive Waste (GAO-07-762), dated May 2007,*" and I appreciate the opportunity to provide comments.

The Government Accountability Office (GAO) concludes that the delay in the anticipated start date for the Hanford Waste Treatment Plant (WTP) has brought the need for supplemental treatment technology into question. While the extent to which supplemental treatment would be used is imprecise, the Department of Energy (DOE) expects that there is a very high likelihood that the cleanup mission would benefit from an added capacity to treat low-activity waste. Based on technical and management evaluations, there is potential benefit in alternative treatment technologies such as bulk vitrification that could fill this need.

We disagree with the assertions made in the report that decisions were made, either formally or informally, to not follow DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets (June 2006)*. Since the inception of the Demonstration Bulk Vitrification System (DBVS) Project, it has been and remains subject to the requirements of DOE Order 413.3A and predecessor project management orders. The DBVS Project is an expense funded research and testing project to determine the viability of a supplemental waste treatment technology and is a subproject within the larger Radioactive Liquid Tank Waste Stabilization and Disposition Project.

As such, the DBVS Project has been subject to multiple, formal independent project management and technical and safety reviews and validations by organizations both inside and outside the Department. As early as November 2004, the Office of Environmental Management recognized that as the project matured and moved from bench-scale to larger, engineering-scale testing, project uncertainties and technical risks would be better defined and the project would warrant additional project management oversight. Thus, the provisions of the DOE project management orders, including the critical decision process, were implemented. This approach was reaffirmed on August 10, 2005, in Secretary of Energy Bodman's memorandum on Improving Project Management within the Department.



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I want to be unequivocally clear that DOE has not committed to use bulk vitrification for supplemental treatment because we are not yet at that critical decision point in the project management process. However, because of its potential as a treatment technology, DOE has had an interest in the DBVS Project as a component of a research and development program to collect information that would allow a comparative decision. As you know, this project recently underwent an external technical review. Related testing and analysis continues for the purpose of validation of the technical baseline.

DOE is also currently performing an assessment of mission completion options for cleanup of Hanford tanks, of which bulk vitrification is one of several possible supplemental treatment technologies. Furthermore, an independent team is being commissioned to validate the cost and schedule baselines in June 2007. DOE periodically updates a system plan which accounts for waste treatment pathways involving the WTP and other disposition paths such as supplemental treatment. We believe it would be an extreme disservice to abruptly cancel our evaluation of this approach before we have data upon which to base a decision.

We have enclosed more specific comments on the report regarding technical aspects of DBVS testing history and interpretations referenced in the report.

If you have any further questions, please contact me at (202) 586-7709 or Mr. Mark A. Gilbertson, Deputy Assistant Secretary for Engineering and Technology, at (202) 586-5042.

Sincerely,



James A. Rispoli
Assistant Secretary for
Environmental Management

Enclosure

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, William R. Swick, Assistant Director; Ryan T. Coles; John Delicath; Doreen Feldman; George Hinman; Jeffrey Larson; and Thomas Perry made significant contributions to this report. Others who made important contributions included Mark Braza, Doreen Eng, and Mehrzad Nadji.

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