United States Government Accountability Office

GAO

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

January 2010

DEPARTMENT OF ENERGY

Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects

GAO-10-199

January 2010

DEPARTMENT OF ENERGY

Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects

GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-10-199, a report to the Subcommittee on Energy and Water Development, Committee on Appropriations, House of Representatives

Why GAO Did This Study

The Department of Energy (DOE) spends billions of dollars on construction projects—those that maintain nuclear weapons, conduct research, and process nuclear waste—and projects that clean up nuclear and hazardous wastes at DOE's sites; these projects are largely executed by contractors. DOE has struggled to keep these projects within cost and schedule estimates. GAO was asked to assess (1) DOE's cost-estimating policies and guidance, (2) the extent to which selected projects' cost estimates reflect best practices compiled in GAO's cost-estimating guide, and (3) DOE's recent actions to improve cost estimating. GAO reviewed relevant documents, including support for cost estimates at three major construction projects—those costing $750 million or more—and one environmental cleanup project, and interviewed DOE officials.

What GAO Recommends

GAO is making six recommendations to improve DOE's cost estimating. Among other things, GAO recommends that DOE (1) ensure its new policy and guide fully reflect cost-estimating best practices, in part by requiring independent cost estimates (ICE) for its major projects, (2) create a centralized, independent cost-estimating capability within the department, and (3) conduct ICEs for those major projects that have not received one. In commenting on a draft of this report, DOE generally agreed with GAO's recommendations.

View GAO-10-199 or key components.
For more information, contact Gene Aloise at (202) 512-3841, or aloisee@gao.gov.

What GAO Found

DOE has not had a policy that establishes standards for cost estimating in place for over a decade, and its guidance is outdated and incomplete, making it difficult for the department to oversee the development of high-quality cost estimates by its contractors. DOE's only cost-estimating direction resides in its project management policy that does not indicate how cost estimates should be developed. In addition, DOE's outdated cost-estimating guide assigns responsibilities to offices that no longer exist and does not fully include most of the best practices from government and industry in GAO's cost-estimating guide. Lacking a documented policy and associated guidance that contain best practices, DOE does not have appropriate internal controls in place that would allow its project managers to provide contractors a standard method for building high-quality cost estimates. DOE has drafted a new cost-estimating policy and guide but the department expects to miss its deadline for issuing them by more than a year.

The cost estimates for the four projects we reviewed did not exemplify the four characteristics of high-quality cost estimates as established by best practices—credible, well-documented, accurate, and comprehensive. The four estimates lacked credibility because DOE did not sufficiently identify the level of confidence associated with the estimates, adequately examine the effects of changing key assumptions on the estimates, or cross-check the estimates with an ICE—an estimate created by an entity with no vested interest in the project. In addition, the four estimates were only partially documented, in part because the projects did not ensure that the contractors thoroughly documented the details of how they developed the estimates. Moreover, all four estimates lacked accuracy because they were not based on a reliable assessment of costs most likely to be incurred. Finally, none of the four estimates were comprehensive; for example, three of the estimates did not include costs associated with the full life cycle of the projects, and the estimating teams' expertise and compositions did not reflect best practices.

Although DOE has undertaken some actions to improve cost estimating, the department may undercut their impact by limiting the role and effectiveness of its new Office of Cost Analysis (OCA). In contrast to best practices and DOE's stated mission for OCA, DOE's draft cost-estimating policy does not require OCA to conduct ICEs at project milestones unless requested by senior management. As a result, major projects are likely to continue to be approved without this independent check, limiting their credibility. Further, locating OCA apart from the existing DOE office that performs a similar but broader review function may lead to duplication of efforts and does not reflect best practices. That is, centralizing a cost-estimating team, rather than maintaining separate teams, facilitates sharing resources and using standard processes. Finally, placing OCA under the office that manages DOE's finances may limit OCA's independence and its access to relevantly skilled staff. It is also inconsistent with Congress' recent action to establish an independent cost-estimating office at the Department of Defense, whose project management responsibilities are similar to those of DOE.

Contents

Figures

Abbreviations

CFO	Chief Financial Officer
DOD	Department of Defense
DOE	Department of Energy
EM	Office of Environmental Management
ICE	independent cost estimate
NNSA	National Nuclear Security Administration
NSLS	National Synchrotron Light Source
OCA	Office of Cost Analysis
OECM	Office of Engineering and Construction Management
Science	Office of Science
WBS	work breakdown structure
Weapons Systems Act	Weapons Systems Acquisition Reform Act of 2009

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

January 14, 2010

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

The Department of Energy (DOE) is the largest civilian contracting agency in the federal government, spending about 90 percent of its annual budget to operate its laboratories, nuclear production facilities, and environmental cleanup sites. DOE's current projects include over 100 construction projects—those that, among other things, help maintain the nuclear weapons stockpile, conduct research and development, and process nuclear waste so it can be disposed of—at an estimated total cost of nearly $90 billion and more than 90 nuclear and hazardous waste cleanup projects at an estimated total cost of more than $220 billion. DOE's two largest program offices, the Office of Environmental Management (EM) and the Office of Science (Science), and the National Nuclear Security Administration (NNSA), a separately organized agency within DOE,[1] manage the vast majority of this work, which is almost entirely conducted by contractors at DOE's sites.

For years, DOE has had difficulty managing its contractor-run projects, and, despite repeated recommendations from us and others regarding specific steps that would improve project management, DOE continues to struggle to keep its projects within their cost, scope, and schedule estimates. For example, we reported in March 2007 that 8 of DOE's 12 major construction projects had exceeded their initial cost estimates by a total of nearly $14 billion;[2] we also reported in September 2008 that 9 of

[1]NNSA was created by the National Defense Authorization Act for Fiscal Year 2000, Pub. L. No. 106-65 (1999), with responsibility for the nation's nuclear weapons, nonproliferation, and naval reactors programs.

[2]Major construction projects are those with a total cost of more than $750 million; major cleanup projects are those whose costs exceed $1 billion in the near term—usually a 5-year window of the project's total estimated life cycle. See GAO, *Department of Energy: Major Construction Projects Need a Consistent Approach for Assessing Technology Readiness to Help Avoid Cost Increases and Delays*, GAO-07-336 (Washington, D.C.: Mar. 27, 2007).

the 10 major EM cleanup projects had experienced cost increases and that DOE had estimated that it needed an additional $25 billion to $42 billion to complete these projects over the initial cost estimates.[3] Because of DOE's history of inadequate management and oversight of its contractors, we have included DOE contract and project management on our list of government programs at high risk for fraud, waste, abuse, and mismanagement since the list's inception in 1990.[4] In response to its continued presence on our list, in 2008, DOE examined the root causes of its contract and project management problems and found that independent cost estimating was one of the top five areas needing improvement.

In March 2009, we issued a cost-estimating guide, a compilation of cost-estimating best practices drawn from across industry and government.[5] Specifically, the cost guide identifies four characteristics of a high-quality—that is, reliable—cost estimate. Such an estimate would be credible, well-documented, accurate, and comprehensive.[6] In addition, the guide lays out 12 key steps that, when followed correctly, should result in high-quality cost estimates.

In this context, you asked us to assess cost estimating at DOE. This report determines (1) the extent to which DOE's policies and guidance support the creation of high-quality cost estimates, (2) the extent to which cost estimates of selected DOE projects reflect the four key characteristics of high-quality cost estimates, and (3) the actions DOE has taken recently to improve its cost estimating.

For the first objective, we analyzed the policies and guidance in effect across DOE and compared them with the best practices identified in GAO's cost-estimating guide. We also interviewed several project

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

[4]Because of progress DOE has made in this area since 2007, in 2009 we narrowed the scope of this high-risk area to focus on NNSA and EM, although projects across DOE continue to receive scrutiny.

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

[6]In the context of our cost guide, a cost estimate is the summation of individual cost elements, using established methods and valid data, to estimate the future costs of a project, based on what is known today.

managers to identify the policies and guidance they followed when overseeing their contractors' work in generating their cost estimates. For the second objective, we reviewed the most recent total project cost estimates from each of four selected DOE projects, including NNSA: three major construction projects—Science's National Synchrotron Light Source-II at Brookhaven National Laboratory in New York, NNSA's Uranium Processing Facility at Y-12 National Security Complex in Tennessee, and EM's Salt Waste Processing Facility at the Savannah River Site in South Carolina—and one environmental cleanup project, EM's decontamination and decommissioning project for the Y-12 National Security Complex in Tennessee (EM Cleanup at Y-12). We compared the methods used to develop these estimates with cost-estimating best practices. For the third objective, we reviewed documentation of proposed and recently implemented DOE actions and evaluated it against the best practices in our cost-estimating guide. We also interviewed department-level management officials, including NNSA, and officials from EM and Science. Appendix I contains additional information on our scope and methodology.

We conducted this performance audit from September 2008 to January 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

DOE relies on its contractors to operate its sites and carry out its diverse missions, including developing, maintaining, and securing the nation's nuclear weapons capability; cleaning up the nuclear and hazardous wastes resulting from more than 50 years of weapons production; and conducting basic energy and scientific research, such as mapping the human genome. This mission work is carried out under the direction of DOE's program offices, including EM and Science, and NNSA.

Project cost estimates are a necessary part of DOE's work for many reasons—for example, to support decisions about funding one project over another, to evaluate resource requirements at key project milestones, and to develop performance baselines. Having a realistic, up-to-date estimate of projected costs—one that is continually revised as the project matures—supports the development of annual budget requests, supports

effective resource allocation, and increases the probability of a project's success.

DOE's Project Management Order

In 2000, DOE issued Order 413, which established a process for managing projects, from identification of need through project completion.[7] This project management order applies to construction projects—projects that build large complexes that often house unique equipment and technologies such as those that process waste or other radioactive material—and environmental cleanup projects, also referred to as "capital assets." Specifically, the order establishes five major milestones—or "critical decision points"—that span the life of a project.

- Milestone 0: Approve mission need. DOE formally establishes the project and begins the process of conceptual planning and identifying a range of alternative approaches to meet the identified need.
- Milestone 1: Approve an approach and cost range. At this milestone, DOE completes the conceptual design, selects its preferred approach, and approves the project's preliminary cost range.
- Milestone 2: Approve the performance baseline—defined as a project's cost, schedule, and scope (the activities needed to achieve project goals). At this milestone, DOE completes its preliminary design and develops a definitive cost estimate. For construction projects, the cost estimate is now a point estimate and no longer a range; for cleanup projects, the cost estimate is also a point estimate but includes only the near-term scope of the project, covering about a 5-year period.
- Milestone 3: Approve the start of construction. At this milestone, design and engineering are essentially complete and have been reviewed, and project construction or implementation begins.
- Milestone 4: Approve the start of operations or project completion. For construction projects, at this milestone DOE completes the project and begins the transition to operations. For cleanup projects, this milestone represents completion of the project's activities and turnover of responsibility for management to another organization.

[7]DOE Order 413.3A was approved in 2006, and changed in 2008. This order cancels DOE Order 413.3, which was issued in 2000. For this report, we use Order 413 to refer to the order in effect, unless otherwise specified.

Order 413 specifies the requirements that must be met, along with the documentation necessary, to move past each milestone; the order also requires that DOE senior management review the supporting documentation and approve the project at each milestone. DOE also provides suggested approaches for meeting the requirements contained in Order 413 through additional guidance.

DOE's project management order also requires that the department conduct a variety of independent reviews of projects at the major milestones. For example, external independent reviews examine a project's estimated cost, scope, and schedule and are intended to provide reasonable assurance that the project can be successfully executed on time and within budget. These reviews are to be conducted by DOE's Office of Engineering and Construction Management (OECM)—an independent office outside the program offices— at milestone 2 for projects that cost $100 million or more and at milestone 3 for the major projects. For projects estimated to cost less than $100 million, Order 413 requires independent project reviews, which serve a similar function. Independent project reviews are required to be conducted at milestones 2 and 3 by reviewers from the respective program office or NNSA, who have no association with the project being reviewed. Order 413 also requires a technical independent project review for nuclear projects approaching milestone 1; this review focuses on ensuring that the project's design integrates safety and security measures.

In validating a project's cost estimate as part of an external independent review or independent project review, reviewers have a number of methods available to them. According to the best practices compiled in our cost guide, the most rigorous method is the independent cost estimate (ICE). Generated by an entity that has no stake in the approval of the project, an ICE provides an independent view of expected project costs. An ICE is usually developed based on the same technical parameters as the project team's estimate, so the estimates are comparable. Conducting an ICE is especially important at major milestones because it provides senior decision makers with a more objective assessment of the likely cost of a project. A second, less rigorous method for validating a project's cost estimate—an independent cost review—focuses on examining the estimate's supporting documentation and interviewing relevant staff. Moreover, independent cost reviews address the cost estimate's high-value, high-risk, and high-interest aspects without evaluating the remainder of the estimate.

Evolution of Cost Estimating at DOE

DOE's approach to managing the work its contractors perform, including developing cost estimates, has changed substantially several times over the past 30 years. In 1982, we reported that DOE lacked sufficient guidance to provide to its contractors for developing cost estimates.[8] DOE subsequently implemented a cost-estimating policy that increased oversight by, among other things, placing a headquarters-based office in charge of cost estimating and requiring it to conduct independent cost estimates. The policy also directed DOE to establish guidance that outlined procedures to be used by contractors when generating estimates and by DOE officials reviewing them. In the mid-1990s, however, as part of a governmentwide management reform movement, DOE rescinded its cost-estimating policy and replaced it with a less prescriptive one that did not contain specifics on cost estimating but rather focused on managing the life cycles of the department's physical assets. DOE has acknowledged that some of its actions likely went too far in removing oversight of the work of its contractors, and, over the past several years, the department has taken steps to reintroduce some cost-estimating oversight functions. However, some of these efforts were never officially implemented or were abandoned. For example, DOE proposed to create a "cost engineering group" in 2002 with a mission to improve DOE's cost estimating, but the effort was never fully implemented.

In late 2007, DOE initiated an effort to address its contract and project management challenges, which involved identifying issues that significantly impeded the department's ability to complete projects within budget and on schedule. DOE undertook this exercise—known as a root cause analysis—as part of its effort to be removed from our list of agencies at high risk for fraud, waste, abuse, and mismanagement. DOE senior staff identified an insufficient independent cost estimating capability as one of the top five reasons that DOE was unable to complete projects on cost and schedule—the other top reasons were inadequate front-end planning, biased identification and management of risks associated with projects, failure to request and obtain adequate funding for projects, and inadequate federal personnel, including cost estimators. DOE officials identified root causes associated with the department's challenges—for cost estimating, these included a lack of policy or standards, lack of personnel with appropriate skills, and lack of databases with historical cost information. In mid-2008, DOE adopted a corrective

[8]GAO, *Further Improvements Needed in the Department of Energy for Estimating and Reporting Project Costs*, GAO/MASAD-82-37 (Washington, D.C.: May 26, 1982).

action plan designed to mitigate the issues identified in the root cause analysis. The corrective action plan includes a set of actions designed to establish and implement a "federal independent government cost estimating capability" to address the issues related to cost estimating.

Cost-Estimating Best Practices

Drawing from federal cost-estimating organizations and industry, our cost-estimating guide includes four characteristics of a high-quality cost estimate that management can use for making informed decisions.[9] A high-quality cost estimate is credible, well-documented, accurate, and comprehensive. Following are some of the criteria that the cost-estimating guide cites as central to achieving these characteristics. An estimate is

- *credible* when it has been cross-checked with independent cost estimates, the level of confidence associated with the point estimate has been identified,[10] and a sensitivity analysis has been conducted—that is, the project has examined the effect of changing one assumption related to each project activity while holding all other variables constant in order to identify which variable most affects the cost estimate;
- *well-documented* when supporting documentation is accompanied by a narrative explaining the process, sources, and methods used to create the estimate and contains the underlying data used to develop the estimate;
- *accurate* when it is not overly conservative or too optimistic and based on an assessment of the costs most likely to be incurred; and
- *comprehensive* when it accounts for all possible costs associated with a project, is structured in sufficient detail to ensure that costs are neither omitted nor double-counted, and the estimating teams' composition is commensurate with the assignment.

In addition, our cost guide lays out 12 key steps that should result in high-quality cost estimates. The guide also contains hundreds of best practices drawn from across industry and government for carrying out these steps.

[9] GAO-09-3SP.

[10] A point estimate is the best guess or most likely value for the cost estimate, given the underlying data. The level of confidence for the point estimate is the probability that the point estimate will actually be met. For example, if the confidence level for a point estimate is 80 percent, there is an 80 percent chance that the final cost will be at or below the point estimate and a 20 percent chance that costs will exceed the point estimate.

Appendix II shows how these 12 key steps relate to each characteristic of a high-quality cost estimate.

DOE Lacks a Cost-Estimating Policy and Its Guidance Is Outdated and Incomplete, Impeding the Department's Development of High-Quality Cost Estimates

DOE has not had a cost-estimating policy in place for more than 10 years, one factor that makes it difficult for the department to oversee the development of high-quality cost estimates. A cost-estimating policy would establish roles and responsibilities for those preparing, reviewing, and updating all types of cost estimates, including independent cost estimates. A policy would also identify when different cost estimates would be conducted, while also serving as a mechanism for providing standard cost-estimating procedures to agency officials and contractors. As we have previously reported, the lack of a cost-estimating policy at other agencies has led to cost estimates of poor quality.[11]

The only direction DOE currently provides related to project cost estimating is contained in its project management order, which states that cost estimates should be developed and reviewed at most of the major milestones that span the life of a project. For example, the order simply states that the performance baseline developed for milestone 2 should be a "definitive cost estimate," encompassing the total project cost; it does not specify how the cost estimate should be developed. In addition, the order sets out requirements for the type of cost estimate project teams need to produce at each milestone—for example, ranges versus detailed point estimates—but does not identify which phases of a project should be included in each estimate (e.g., research and development, operations or decommissioning) or how the estimate should be maintained throughout the life of the project. Moreover, guidance accompanying the order contains a description of the process a project team could follow when developing the cost portion of a performance baseline, but that description is limited as well. For example, the guidance discusses the importance of including certain information in the estimate's supporting documentation, such as the cost-estimating methodology used, but does not offer direction on how to choose the appropriate methodology.

[11]GAO, *Information Technology: FBI Following a Number of Key Acquisition Practices on New Case Management System, but Improvements Still Needed*, GAO-07-912 (Washington, D.C.: July 30, 2007); *Telecommunications: GSA Has Accumulated Adequate Funding for Transition to New Contracts but Needs Cost Estimation Policy*, GAO-07-268 (Washington, D.C.: Feb. 23, 2007); *Homeland Security: Recommendations to Improve Management of Key Border Security Program Need to Be Implemented*, GAO-06-296 (Washington, D.C.: Feb. 14, 2006).

Regarding the direction on reviewing cost estimates, while DOE's project management order specifies that its projects receive either an external independent review or an independent project review prior to approval of both milestone 2 (the approval of the performance baseline) and milestone 3 (the approval of the start of construction), the order is not clear on when an external independent review should include an ICE, and the order is silent on the method to be used for an independent project review. Although, as explained in our cost guide, an ICE is considered a best practice, the order states that ICEs should be done only for major projects where "complexity, risk, cost or other factors create a significant cost exposure" for the department; however, it does not define what is meant by "significant." Moreover, even though DOE officials have acknowledged that the department's major projects would benefit from ICEs, OECM has not conducted them, and instead has traditionally examined project cost estimates through independent cost reviews, a less rigorous approach. We recently reported that the usefulness of these independent cost reviews is questionable given that 4 of the 10 DOE major cleanup projects we reviewed in 2008 had significantly increased their cost estimates even though these reviews had found the estimates were valid.[12] Moreover, the project management order does not require an independent review of any project's cost estimate prior to milestone 1, even though, according to senior DOE officials, there is significant risk to the project at this early milestone given the large number of unknowns that could affect the project team's ability to complete the project within cost and on schedule.

Although DOE lacks a cost-estimating policy, the cost-estimating guide it developed in the 1990s remains in effect;[13] this guide is out of date and lacks important components. For example, the guide assigns responsibilities to offices that no longer exist and is based on policies that have been canceled. More specifically, the guide's description of DOE's project management system is based on the policy that preceded Order 413, and the guide states that it serves as a companion to DOE's defunct cost-estimating policy. In addition, the guide does not contain sufficient information to help ensure that a cost estimator following the guide will successfully create a high-quality cost estimate. Table 1 shows the extent to which DOE's guide contains information on the steps identified as best practices for developing high-quality cost estimates.

[12]GAO-08-1081.

[13]DOE, *Cost Estimating Guide*, DOE G 430.1-1, 3/28/1997.

Table 1: Extent to Which DOE's Cost-Estimating Guide Contains 12 Key Steps for Developing High-Quality Cost Estimates

12 key steps	Fully	Mostly	Partially	Somewhat	Not
1. Define estimate's purpose, scope, and schedule	●				
2. Develop the estimating plan	●				
3. Define the program			●		
4. Determine the estimating approach				●	
5. Identify ground rules and assumptions				●	
6. Obtain the data		●			
7. Develop the point estimate and compare it to an independent cost estimate		●			
8. Conduct sensitivity analysis					●
9. Conduct risk and uncertainty analysis				●	
10. Document the estimate		●			
11. Present the estimate to management					●
12. Update the estimate to reflect actual costs and changes				●	

Source: GAO Analysis of DOE Guide 430.1-1 (1997).

Note: The ratings we used in this analysis are as follows: "Fully" means that the guide included information that satisfied the criterion; "Mostly" means that the guide included the majority of the information to satisfy the criterion; "Partially" means that the guide included information satisfying part of the criterion; "Somewhat" means that the guide included information satisfying a minor part of the criterion; and "Not" means that the guide did not include information that satisfied the criterion.

Specifically, DOE's guide contains all the information necessary to fully carry out 2 of the 12 key steps identified in our cost guide as necessary for developing high-quality cost estimates: defining the estimate's purpose, scope, and schedule and developing an estimating plan. Defining the estimate's purpose, scope, and schedule is important to ensure that the estimate supports the department's missions, goals, and strategic objectives; that it will meet the customer's needs; and that there will be sufficient time to develop the estimate. In addition, developing a written estimating plan that details a master schedule of specific tasks, responsible parties, and due dates helps ensure that all stakeholders are involved and aware of their responsibilities and deadlines. Moreover, although the guide includes varying degrees of information for mostly, partially, or somewhat carrying out 8 of the 12 steps, it contains no specifics about 2 other key steps: conducting a sensitivity analysis and presenting the estimate to management for approval. A sensitivity analysis is important because it determines the effects of changing key assumptions underlying the cost estimate and allows project managers to develop appropriate mitigation measures, where warranted. In addition, according to best practices, management should be briefed on how a cost

estimate was developed before it is approved, and that briefing should include risks associated with the underlying data and methods. While DOE's project management order identifies the decision maker responsible for approving project cost estimates, the DOE guide does not provide information on what to include when briefing management.

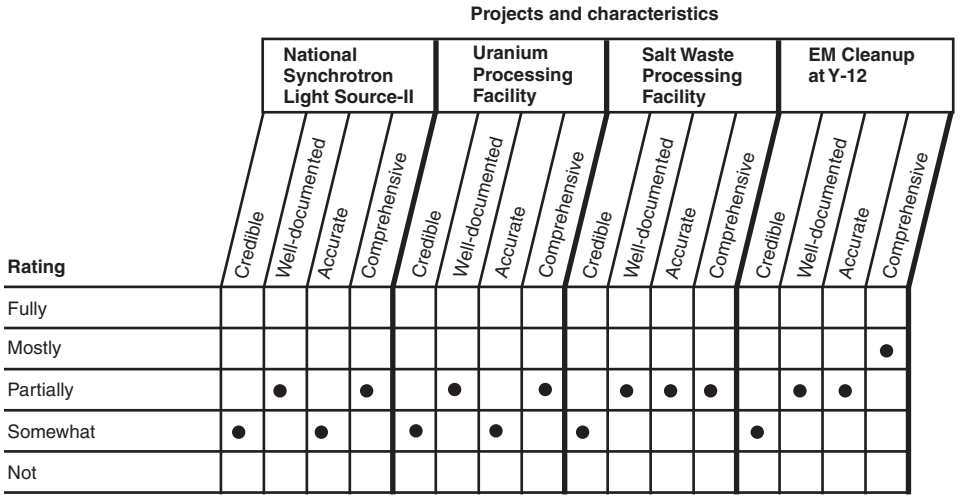
Without a documented cost-estimating policy and related guidance, DOE project managers do not have a standard method to provide to their contractors to help them build high-quality cost estimates or for DOE to use as a basis for evaluating those estimates. According to the *Standards for Internal Control in the Federal Government*, federal agencies are to employ internal control activities, such as reviews by management, to help ensure that management's directives are carried out and to determine if agencies are effectively and efficiently using resources.[14] However, DOE project managers do not have a documented standard to use when comparing actual performance of its contractors—in terms of the cost estimates the contractors deliver—to planned or expected results. As a result, for the four projects we reviewed, contractors had developed cost estimates using their own company policies, along with the minimal direction provided by DOE's project management order, and some of the project managers we spoke with looked elsewhere for guidance. For example, one DOE project manager said he still used the cost-estimating policy DOE canceled in the mid-1990s to help oversee the contractor; another project manager said he relied on cost-estimating guidance that had been drafted but never formalized. Specifically, in 2004, a team drafted an update to DOE's cost-estimating guide that, according to one of its authors, was ready to be submitted for agency-wide approval when senior-level support for it evaporated. According to this official, although it was never officially adopted, the draft guide is still shared among DOE staff, especially those within EM. According to the corrective action plan DOE developed to address its contract and project management issues, it has identified the need to update its cost-estimating guide, as well as to re-establish a cost-estimating policy. According to DOE officials, it has begun drafting the new policy and guide.

[14]GAO, *Standards for Internal Control in the Federal Government*, GAO/AIMD-00-21.3.1 (Washington, D.C.: Nov. 1999).

The Four Project Cost Estimates We Reviewed Were Not High-Quality

Our analysis of the four DOE project cost estimates we reviewed found that they did not fully achieve the four characteristics of high-quality estimates as identified by the professional cost-estimating community and documented in our cost guide—credible, well-documented, accurate, and comprehensive. More specifically, the four estimates were only somewhat credible and only partially well-documented, accurate, and comprehensive, as shown in figure 1. Appendix III contains more information about each project, including the project cost estimate, stage of development, and how well the project followed the 12 key steps of the cost-estimating process that lead to high-quality estimates.

Figure 1: Extent to Which Four Cost Estimates We Reviewed Were Credible, Well-Documented, Accurate, and Comprehensive



Source: GAO analysis.

Note: The ratings we used in this analysis are as follows: "Fully" means that the program provided documentation that satisfied the criterion; "Mostly" means that the program provided the majority of the documentation to satisfy the criterion; "Partially" means that the program provided documentation satisfying part of the criterion; "Somewhat" means that the program provided documentation satisfying a minor part of the criterion; and "Not" means that the program did not provide documentation that satisfied the criterion.

The Four Project Cost Estimates We Reviewed Were Somewhat Credible

The cost estimates of the four projects we reviewed lacked credibility because DOE did not sufficiently cross-check the projects' cost estimates with ICEs, use best practices when identifying the level of confidence associated with the estimates, or sufficiently analyze project sensitivities. More specifically, DOE did not conduct ICEs for three of the four projects—National Synchrotron Light Source-II, Uranium Processing

Facility, and EM Cleanup at Y-12. Instead, these three projects received independent cost reviews as part of external independent reviews or independent project reviews. An independent cost review is less rigorous than an ICE because it addresses the cost estimate's high-value, high-risk, and high-interest aspects without evaluating the remainder of the estimate. In some cases, the project teams or program offices conducted additional reviews beyond what was required under DOE's project management order. For example, a team from a number of DOE's national labs and Science officials performed a peer review of the National Synchrotron Light Source-II estimate, and its contractor hired a firm to conduct two independent estimates of the construction portion of the project's scope, though not for the entire project. These additional reviews add value, but are not as independent as the best practice—although the contractor obtained an independent estimate for the construction portion, it was not conducted by an entity without a stake in the approval of the project, compromising the estimate's independence.

In contrast, although DOE conducted an ICE at the fourth project, Salt Waste Processing Facility, after DOE's Deputy Secretary requested it, DOE did not follow best practices when reconciling the ICE's results with the project team's estimate, contributing to the project estimate's lack of credibility. By extrapolating costs from a smaller scale, similar project already operational near the Salt Waste facility, the ICE team estimated the cost for the project could reach $2.7 billion, more than twice as much as the project team's estimate of $1.3 billion. According to our cost guide, ICEs are usually higher and more accurate than baseline estimates, which are created by project teams; if a project's estimate is close to an ICE's results, one can be more confident that it is accurate. It is also a best practice that, after the ICE is completed, the ICE team and project team identify the major differences between the two estimates and, where possible, reconcile those differences; a synopsis of the estimates and their differences should then be provided to management. According to officials from the ICE team and the project team, this formal process did not occur. The difference between the ICE and the project team's estimate primarily stemmed from the ICE's incorporation of additional costs to cover risks the ICE team felt were insufficiently addressed in the project team's

estimate.[15] The ICE team provided the project with a high-level summary of its findings but did not provide the supporting details of its estimate. Based on the information provided, the project team increased its estimated total cost by $100 million. According to project officials, by increasing the estimate by this amount, the estimate included sufficient funding to mitigate the risks raised by the ICE team. Moreover, during the time DOE conducted the ICE, OECM conducted an independent cost review as part of its external independent review and, after taking the ICE's conclusions into consideration, validated the project team's final estimate of $1.3 billion. It is too soon to tell whether the risks identified by the ICE will materialize; the project was approved to begin full construction in January 2009 and has had some challenges with quality assurance in constructing the foundation for the building, but according to the project team, these issues are not expected to have a significant impact on performance.

Additionally, the methods DOE used to identify the level of confidence associated with the cost estimates for the four projects only partially reflected best practices, which limited the estimates' credibility. Although each project conducted a risk analysis to identify the confidence level associated with its estimate—if calculated correctly, a confidence level tells the likelihood of the project being completed at or under a specific cost—none of the projects used best practices when constructing the computer models used to support the risk analysis and the resulting confidence level.[16] For example, one significant problem common across all four projects was that, when building their models, the projects did not correlate—or link—different project activities that are dependent on or tied to one another. Correlation captures the fact that, for example, technical performance problems experienced by one activity could result in unexpected design changes and unplanned testing for other activities. Similarly, a schedule slip experienced by one activity could have a

[15]The $2.7 billion estimated cost from the ICE also included $360 million to cover costs associated with the demonstration phase of the project, in which a facility is turned on and tested to see whether it will work as designed. According to project officials, these costs are captured by a separate project that will fund the operation of the facility once construction is complete. Even without these hot commissioning costs, the ICE was more than $1 billion higher than the project team's estimate.

[16]Before conducting a risk analysis, each of the four projects identified risks associated with executing the project that could limit the project team's ability to deliver the project on cost and schedule, such as increases in commodity prices, unexpected need for greater design complexity, or technology uncertainty.

cascading effect on other activities, such as if a supplier delivers an item late, other scheduled deliveries could be missed, resulting in additional cost. According to best practices, ignoring correlation, as the four projects did, can significantly affect the results of a risk analysis, creating a false sense of confidence in the resulting estimate. As a result, the confidence levels associated with the projects' cost estimates—ranging from 80 percent to 95 percent confidence—are likely overstated.

A second problem with how the estimates' levels of confidence were identified was that two of the projects did not use best practices in determining their contingency reserves.[17] According to best practices, the difference in cost between the project team's estimate and the desired confidence level should determine the required contingency amount. For example, if a project team estimates its cost and determines, through its risk analysis, that it has 50 percent confidence in completing the project for no more than that cost, in order to increase the confidence level of the estimate, it should add contingency reserves based on the statistical output from the risk analysis.[18] In contrast, two of the projects we reviewed did not add contingency reserves to their estimates using this method. For example, the Uranium Processing Facility contractor conducted a risk analysis in accordance with many best practices that showed that, by adding contingency reserves, the project would have 95 percent confidence of success in completing the project with a $2.3 billion estimate. However, contrary to best practices, NNSA headquarters officials then added more than $1 billion in contingency to the contractor's estimate, bringing the high end of the project's estimated cost range up to $3.5 billion. This billion-dollar "allowance" was added, according to a senior NNSA official, because the experts reviewing the project thought it would require significantly more than the project team's $2.3 billion estimate to complete the project, and NNSA did not want to exceed the high end of its cost estimate range in the future. The allowance was supported by a memo outlining risks to the project it was intended to cover that were not included in the initial risk analysis, including material

[17]Contingency reserves are funds that may be needed to cover potential cost increases stemming from a variety of project risks.

[18]As we reported in our cost guide, how much contingency should be allocated to a program beyond the 50 percent confidence level depends on the program cost growth an agency is willing to risk. While no specific confidence level is considered a best practice, experts agree that project cost estimates should be budgeted to at least the 50 percent confidence level, but budgeting to a higher level (for example, 70 percent to 80 percent, or the mean) is now common practice.

and commodity cost growth and schedule impacts associated with delayed decision making or arrival of expected funds; the high-level nature of the memo stands in sharp contrast to the detail involved in the project team's risk analysis. Further, because the risks in the memo were not incorporated into the project team's risk analysis, the confidence level associated with the $3.5 billion high end of the estimate range is not known, leaving decision makers within DOE and Congress without a sound basis for determining appropriate funding levels for the project.

A third problem with how projects identified the level of confidence associated with their estimates was that two of the projects we reviewed—EM Cleanup at Y-12 and Uranium Processing Facility—included contingency reserves in their cost estimates but their program offices did not budget for all of it, limiting the funding available to cover the costs associated with risks that may materialize once the project is under way. According to best practices, having adequate funding is paramount for optimal project execution, since it can take many months to obtain necessary funding to address an emergent issue. Without readily available risk funding, additional cost growth is likely. For example, the EM Cleanup at Y-12 project's near-term cost estimate included more than $50 million in contingency reserves, but EM has not committed to funding any of it. Without this contingency reserve available, according to the project baseline, the likelihood of completing the project's near-term scope within its budget is 50 percent. As we previously reported, although EM project managers build contingency funding into their near-term and out-year estimates, EM management does not generally include funding in its budget requests to cover contingency for cleanup projects until after it is actually needed to address a problem. We also reported that this practice was likely a contributing factor to the cost increases and schedule delays recently experienced by EM's major cleanup projects.[19] Similarly, even though the approved upper end of Uranium Processing Facility's cost estimate range is $3.5 billion, NNSA does not intend to include the $1 billion allowance in the project's budget.[20] According to the memo explaining the allowance, if any of the risks covered by the allowance were to occur, they would be beyond NNSA's budget parameters and would have to be funded on a case-by-case basis.

[19]GAO-08-1081.

[20]The cost estimate we reviewed of the Uranium Processing Facility project was a cost estimate range because the project's most recently approved estimate was for milestone 1 (the approval of an approach and cost range).

Finally, none of the four projects conducted a sensitivity analysis, further undermining their estimates' credibility. By conducting this analysis, the variable that most affects the cost estimate becomes more obvious, thereby allowing project managers to develop risk mitigation steps specific to that variable. Because this analysis can help decision makers choose among alternatives, it is especially important early in a project's life cycle while assumptions can still be changed. For the one project we reviewed that was at such an early stage of development—Uranium Processing Facility—not conducting a sensitivity analysis meant that project managers were not able to give decision makers an understanding of the impacts on project cost of, for example, varying the square footage of the building.

The Four Project Estimates Were Only Partially Documented, Accurate, and Comprehensive

The four estimates we reviewed lacked complete documentation. For example, three of the four projects did not generate a narrative summary explaining the process, sources, and methods used to create the estimates, and outlining clearly and concisely the cost estimate results, including information about cost drivers and high-risk areas. Documenting the estimate in a narrative at this level of detail provides enough information so that someone unfamiliar with the project could easily recreate or update it. In addition, none of the four projects systematically included the underlying data on which the estimates were based in the documentation sets, which can cause an estimate's credibility to suffer because the rationale supporting the specific costs is not clear. More specifically, at the EM Cleanup at Y-12 project, while the project team created notebooks containing supporting documentation for the estimate that included detailed descriptions of how each cost was derived, these notebooks did not consistently contain evidence of the source data—for example, quotes from vendors or historical data from another project—used for each calculation. Similarly, cost estimators at Uranium Processing Facility did not collect evidence of all the data that supported costs contained in the estimate, which led to a lack of transparency of what work activities were included in the estimate. As a result, after the estimate was approved, as project engineers continued to identify activities necessary for constructing the facility, there was no documented record for them to refer to in order to determine which activities were already present in the estimate or whether they represented new work that would increase the cost of the project.

Moreover, the four project cost estimates we reviewed lacked accuracy because they were not based on a reliable assessment of costs most likely to be incurred. For example, two of the projects—Uranium Processing

Facility and National Synchrotron Light Source-II—did not always use appropriate estimating methodologies. These projects both used a highly detailed method that is appropriate for a project whose design is stable and not anticipated to change. However, this was not the case for Uranium Processing Facility or for the portions of National Synchrotron Light Source-II that had not been fully designed yet. As a result, according to best practices, a less detailed methodology focused more on using statistical relationships to extrapolate costs would have been more appropriate. Further, NNSA's technical independent review of the Uranium Processing Facility estimate echoed this sentiment, stating that the project's cost estimate range was unsupported in part because it was prepared with significant detail—for example, the estimate provided a count of pipings and fittings for the facility—despite the fact that there had been no design of technical systems or of the building on which to base these details. In addition, three of the four project estimates—Salt Waste Processing Facility, National Synchrotron Light Source-II, and Uranium Processing Facility—did not use adequate data to estimate the projects' costs. According to best practices, basing an estimate largely on valid and useful historical data is a key step in developing a sound cost estimate; however, these three estimates were not primarily based on relevant historical actual costs. For example, at National Synchrotron Light Source-II, only 12 percent of the cost estimate was based on historical costs. For the remainder of the estimate, the project team relied heavily on the professional opinion of the technical experts working on the project. Although these individuals had significant experience working with other light sources, relying on judgment lacks objectivity and introduces bias into the estimate. These projects did not use historical data, in part, because, in contrast to best practices, DOE does not have a database of historical costs from previously completed projects available for newer projects to use, nor does the department explicitly require projects to use historical data when generating cost estimates. In addition, even if historical data did exist, they would not always be available for use. For example, at Uranium Processing Facility, historical costs from a comparable project that was built next door would have been directly relevant but were not available because of their proprietary nature. In addition, although the EM Cleanup at Y-12 project had directly relevant historical actual costs to draw from, its cost estimate lacked accuracy in part because the project team did not determine the validity of the statistical relationships it used when calculating the out-year portion of its estimate.

Finally, none of the four projects were fully comprehensive, in part because they did not account for all possible costs. Specifically, Salt Waste

Processing Facility, National Synchrotron Light Source-II, and Uranium Processing Facility did not include costs associated with the full life of the project. According to best practices, life cycle costing—a "cradle to grave" approach that includes costs from design and construction through operations, decommissioning, and disposal—enhances decision making and provides valuable information about how much projects are expected to cost over time. However, DOE's Order 413 does not require construction projects to produce life cycle cost estimates at every major milestone; as a result, the three construction project estimates we reviewed represented a more limited scope of activities.[21] For instance, the estimate for Salt Waste Processing Facility did not include costs to maintain and operate the facility, including the time during which the facility is turned on and tested to see whether it will work as designed—known as "hot commissioning." According to DOE officials, these costs were captured under a separate operations project. As a result, the full life cycle cost of the facility, including the operations it supports, is not transparent or easily identified. The ICE for Salt Waste Processing Facility recommended that DOE at least incorporate the hot commissioning costs into the total project cost, since it more completely captures the work it takes to prepare the facility for full operations. In response, according to agency officials, DOE is considering changing its policy to include these costs in the scope of future construction projects.

In addition, the cost estimates of National Synchrotron Light Source-II and Uranium Processing Facility left out significant portions of scope required to complete construction of their facilities, further limiting their comprehensiveness. In particular, although National Synchrotron Light Source-II was designed to include 58 points at which the X-ray generated by the light source is directed into experimental facilities—known as beamlines—the project's scope, and thus, its cost estimate, only included funding for 6 of those beamlines. Based on the data supplied by a senior project official, we estimate that including funding for the rest of the beamlines would add roughly $400 million to $500 million to the estimate—about 50 percent more than the approved total project cost. According to project officials, the costs for the beamlines were not included in the scope of the project because other agencies are expected

[21]Although not required at every milestone, Order 413 and its accompanying guidance direct DOE's construction projects to generate a life cycle cost estimate to inform the process of selecting the preferred alternative before milestone 1. According to project officials, the three construction projects we reviewed, including Uranium Processing Facility, developed life cycle costs as part of this process.

to contribute funding for them. However, excluding them from the project resulted in a cost estimate that did not include the facility's full—or even partial—capability and did not represent the total cost to the taxpayers. At the Uranium Processing Facility, the cost estimate did not include costs associated with developing technologies that are critical to the facility's functioning but were not yet mature enough to be included in such a facility. Although not part of the total project cost for the facility, these technology development costs are managed and funded by the contractor running the Y-12 site. However, this situation presents a challenge to the project's managers, since the funding to develop these technologies is not under their control.[22] Moreover, Uranium Processing Facility's $1.4 billion cost estimate for the low end of its range includes less of the project's scope than the high end of its range. For example, while the $3.5 billion high end of the range includes costs associated with a tunnel that will be used to safely transport dangerous materials between Uranium Processing Facility and an adjacent storage building, the low end does not include this tunnel. Because the low end of the estimate range does not include the same scope as the high end, presenting $1.4 billion as a possible cost of the facility is misleading, especially given that the project's risk analysis shows there is a zero percent likelihood of constructing the facility for that amount.

Finally, the four projects' estimates lacked comprehensiveness because the teams who generated the estimates were not comprised in accordance with best practices. Although each of these teams was led by or included some experienced and trained cost analysts, the teams were generally made up of scientists and engineers who did not appear to have such experience or training. Further, it was the contractors' staff—not federal staff—who developed the cost estimates for all four of the projects we reviewed. As we reported in our cost guide, reliance on support contractors raises questions from the cost-estimating community about whether numbers and qualifications of federal personnel are sufficient to provide oversight of and insight into contractor cost estimates. At DOE, it appears this is not the case—as part of its effort to address its contract and project management challenges, DOE found that one of the root causes of these problems was its lack of federal personnel, including cost estimators, to oversee its contractors.

[22]Although the estimate does not include the cost for the technology development, it does include contingency reserves to mitigate the risk of the technologies not being ready when they are needed.

DOE Has Begun Taking Actions to Improve Its Cost Estimating, but Actions May Be Hampered by Limited Role and Organizational Location of New Cost Estimating Office and Lack of Coordination between DOE and Its Program Offices

DOE recently initiated a number of actions at the department-wide level to improve its cost estimates, the first of which was to establish the Office of Cost Analysis (OCA) in 2008. OCA has started implementing a number of actions that are designed to improve cost estimating, but these actions may be hampered for various reasons. In addition, some program offices have taken independent steps to improve the quality of their cost estimates, some of which reflect best practices; however, a lack of coordination on some actions may lead to duplication of effort.

DOE Has Begun Taking Actions to Improve Cost Estimating at the Department-wide Level

DOE established OCA in order to improve the department's cost-estimating capabilities and better ensure that its project cost estimates are reliable by providing a new independent cost-estimating function for the department. In addition, as outlined in its recently developed corrective action plan, DOE has given OCA the primary responsibility for implementing the department's cost-estimating improvement efforts. Specifically, DOE tasked OCA with the following actions:

- developing a new cost-estimating policy for the department and updating its guidance on cost estimating;
- conducting independent cost estimates and analyses for major projects;
- developing escalation rates to help program managers and DOE contractors estimate future costs of commodities and labor;
- developing a historical cost database, designed to improve cost-estimating accuracy by allowing project managers and contractors access to historical costs of completed DOE projects;
- developing cost-estimating skills of field office staff, in part through new training courses;

- creating a common work activity structure, known as a work breakdown structure, to better enable side-by-side comparisons of project estimates and to facilitate collecting comparable cost data; and

- identifying lessons learned from external independent reviews and developing relevant corrective actions.

These actions appear to represent a comprehensive approach to improving cost estimates, and although OCA is making progress in completing some of these actions, it has fallen behind on other tasks. Most notably, OCA has developed ICEs for several projects, including the ICE for Salt Waste Processing Facility, and has begun publishing annual escalation rates that projects will be required to use and that are based on OCA's evaluation of economic conditions and industry trends.[23] According to OCA's Director, the office also held its first training course on cost estimating in August 2009 and is establishing an online "Cost Analysis Community Portal" where DOE staff can access training and electronic links to professional development tools. In contrast, OCA missed its December 2008 deadline for completing the new cost-estimating policy and guide. According to OCA's Director, the new cost-estimating policy—Order 415—and the cost-estimating guide are now anticipated to be issued sometime in the first quarter of 2010. Also according to the OCA Director, the office has experienced a delay in completing its historical cost database, which is expected to provide project managers with better data for building future cost estimates. Originally to be completed in June 2009, OCA recently changed its approach for developing the database and now the Director of OCA expects it to be completed in May 2010.

The Limited Role and Organizational Location of DOE's New Independent Cost-Estimating Office May Undercut Improvements

While DOE has made some progress on its cost-estimating improvement efforts, the most recent draft of its cost-estimating policy does not reflect best practices and falls short of fulfilling DOE's stated mission for OCA—to conduct ICEs of major projects before approval of milestones 1, 2, and 3. In fact, the current draft policy does not require OCA to conduct ICEs of any project at any milestone, in contrast to best practices. Instead, the draft directs OCA to conduct ICEs only at the request of DOE senior

[23]Escalation is the provision in a cost estimate that captures increases in the cost of equipment, material, and labor due to continuing price changes over time. Escalation rates and indexes are used to forecast future project costs or to bring historical costs to the present. Most cost estimating is done in current-year dollars and then escalated to the time when the project will be accomplished.

management. Senior DOE officials told us that when OCA could not obtain the support necessary within the department for mandatory ICEs at these milestones, it eliminated the requirement from the draft policy. Consequently, many of DOE's projects will continue to be approved without independent cost estimates, thereby limiting their credibility. In contrast, for many years, Congress has required that the Department of Defense's (DOD) independent cost office, the Office of the Deputy Director for Cost Assessment,[24] perform ICEs of major projects before DOD's equivalent of milestones 2 and 3. Furthermore, Congress recently moved to improve DOD's cost estimating by passing the Weapons Systems Acquisition Reform Act of 2009 (Weapons Systems Act), in which it expanded the requirement that DOD conduct ICEs to include DOD's milestone A, the equivalent of DOE's milestone 1.[25]

DOE's decision to locate the new cost-estimating office where it did within the organization limits OCA's ability to effectively function as intended in several ways. First, instead of locating OCA within an office that has staff with similar skills and expertise and that performs similar functions, such as OECM, DOE located OCA under the Chief Financial Officer's (CFO) Office—an office that serves as the principal advisor for DOE's financial, budgeting, and strategic planning issues. According to best practices, an agency's cost-estimating team should be centralized—that is, consolidated—in order to facilitate the use of standardized processes and more effective sharing of resources. Under the current configuration, however, DOE's cost-estimating functions are split across the two offices. Further, the National Academy of Public Administration reported in July 2009 that DOE's mission-support offices—which include OCA and OECM—need better integration. While the report stated that the department's mission-support offices communicate with one another, they tend to operate independently, and there is no ongoing mechanism to coordinate common efforts. Moreover, complicating the fact that OCA and OECM are in separate offices, their roles and responsibilities are not clear and may overlap. Specifically, the draft cost-estimating policy does not clearly delineate the roles of these two offices, stating only that, "the Office of Cost Analysis will not duplicate cost reviews performed by the Office of Engineering and Construction Management." A senior DOE

[24]Legislation recently changed the name of DOD's independent office from the Cost Analysis Improvement Group; *see* Pub. L. No. 111-23 (2009), *Weapons Systems Acquisition Reform Act of 2009*.

[25]Pub. L. No. 111-23 (2009).

program office official has raised concerns that without a clearer articulation of the roles of these offices, an additional layer of review could be added, leading to duplication of work. This type of duplication occurred at Salt Waste Processing Facility when, prior to milestone 3 and within weeks of each other, OECM performed an independent cost review as part of an external independent review and OCA conducted a separate ICE. Because the reviews were not coordinated, the project team spent extra time separately briefing and providing many of the same documents to each independent team, taking away from the time it could spend executing the project. In addition, the two teams drew very different conclusions. DOE's Deputy Secretary ultimately approved the project at the level recommended by OECM. DOE has developed a draft memorandum of understanding between OCA and OECM to better articulate the roles of each office; however, although the memorandum contains additional details about the responsibilities for each office, it still leaves the department's independent cost-estimating function divided between them.

The second way in which locating OCA under the CFO may not effectively support OCA's ability to fulfill its mission relates to the skills that will be available to OCA within the Office of the CFO. In contrast to OCA, staff in an agency's CFO office—including the CFO—tend to have accounting and financial analysis skills used to develop and evaluate budgets, while OCA staff need to have strong analytical skills to understand engineering and technical details that are used as the basis for developing independent cost estimates. Although DOE's current CFO comes from an analytical background that meshes well with OCA's mission, a more traditional CFO trained as an accountant may not be willing to support OCA's independent cost-estimating function as effectively.

Moreover, the House Appropriations Committee has weighed in on the issue of locating OCA under the Office of the CFO. More specifically, the House Appropriations Committee Chairman's Explanatory Statement that accompanies the Omnibus Appropriations Act of 2009 directed DOE to move OCA's staff and function out of the CFO Office, to be managed by OECM.[26] Subsequently, in its fiscal year 2010 budget request, DOE indicated it had decided against this, instead opting to maintain OCA where it was initially placed in the CFO. In response, the Committee Report accompanying the recently enacted Energy and Water

[26]Pub L. No. 111-85 (2009); *see* 155 Cong. Rec. H1962.

Development and Related Agencies Appropriations Act of 2010 noted DOE's decision and reiterated the Committee's direction that OCA be moved from the Office of the CFO.[27] Further, the report also stated that the Committee generally opposes creating a new office to address an issue with existing mission functions.

Finally, subsuming OCA under another office whose primary responsibilities do not include cost estimation and analysis also diverges from the approach Congress has taken in establishing an independent cost-estimating office at DOD. DOE is similar to DOD in that both agencies rely heavily on contractors to construct complex and unique projects, and both have struggled to develop accurate cost estimates for these projects. The Weapons Systems Act moved DOD's independent cost-estimating office out from under another office within DOD to increase its independence by having it report directly to the Secretary and Deputy Secretary. According to the legislative history, Congress mandated the change to ensure that this office would have the independence and authority to make objective determinations and be able to report these determinations directly to the Secretary and Deputy Secretary.[28] In recent testimony, we also supported the idea of having an independent cost-estimating office at DOD, noting that establishing an independent office that reports directly to DOD's Secretary or Deputy Secretary would provide an increased level of accountability.[29]

Some Program Offices' Actions Offer Potential to Improve Quality of Estimates, but Lack of Coordination on Some Actions May Lead to Duplication of Effort and Rework

Recognizing that their projects' cost performance needed improvement, EM and NNSA recently initiated actions—some of which reflect best practices—to improve their cost estimating, largely independently of the actions being taken concurrently by OCA. At EM, these actions included placing cost estimators at its large sites and establishing an internal cost-estimating office capable of providing cost-estimating assistance primarily to its smaller sites, but also to its large sites on an as-needed basis, including conducting ICEs and training on cost estimating. EM's cost-estimating office has already conducted a number of independent estimates and reviews, including many to support EM's American

[27]Pub. L. No. 111-85 (2009), H.R. Rep. No. 111-203 at 124-125 (2009).

[28]155 Cong. Rec. S5205 – 5224 (2009).

[29]GAO, *Defense Acquisitions: DOD Must Balance Its Needs with Available Resources and Follow an Incremental Approach to Acquiring Weapon Systems*, GAO-09-431T (Washington, D.C.: Mar. 3, 2009).

Recovery and Reinvestment Act work. It has also built a database—Environmental Cost Analysis System—containing historical actual costs from two of EM's cleanup projects and has helped develop a standard way of organizing work scope within a project to ensure all cleanup projects collect actual costs in a way that is consistent with the new database. In addition, NNSA has recently implemented actions to improve its cost-estimating capability. In early 2009, NNSA adopted a new independent cost-estimating policy. Among other things, the policy requires either NNSA or OCA to conduct an ICE prior to approval of milestone 2 for NNSA's major projects—those estimated to cost more than $750 million.[30] By requiring ICEs for these projects at this milestone, NNSA's policy better reflects best practices than DOE's new draft cost-estimating policy. The policy also designates the NNSA project management office to serve as the focal point for all cost-estimating policy and standards within NNSA. Finally, in contrast to the improvements that EM and NNSA are undertaking, Science does not have efforts under way specific to improving its cost estimating. According to the director of Science's project management office, Science has had a process in place for several years to conduct independent project reviews of its projects on an ongoing basis that, in addition to other oversight it performs, already sufficiently validates its cost estimates. We reported in 2008 that although Science has generally achieved its projects' original cost and schedule targets, sometimes it has done so by trimming selected components from some projects' scope.[31] OECM and DOE's Inspector General have expressed concern that such changes in scope may not always preserve a project's technical goals.

Although several of these efforts show potential to improve cost estimating, some of them have not been well coordinated with department-level efforts, which may lead to duplication of effort or inefficiencies. Specifically, we saw two examples of efforts that were not well-coordinated. First, we found that NNSA's new independent cost-estimating policy may conflict with OCA's draft policy on cost estimating. Although NNSA's new policy requires either NNSA or OCA to conduct an

[30]According to NNSA's policy, NNSA should conduct an independent estimate for projects estimated to cost between $100 million and $750 million, and OCA should conduct an independent estimate for projects estimated to cost greater than $750 million.

[31]GAO, *Department of Energy: Office of Science Has Kept Majority of Projects within Budget and on Schedule, but Funding and Other Challenges May Grow*, GAO-08-641 (Washington, D.C.: May 30, 2008).

ICE for NNSA's projects before approving milestone 2, according to a senior NNSA official, NNSA intended to avoid duplicating department-level independent review efforts at that milestone by having the ICE replace the cost review portion of OECM's external independent review. However, OECM officials recently told us they were not aware of NNSA's new policy, and they intend to continue conducting the cost review portion of the external independent review for NNSA's projects in addition to any ICE that NNSA or OCA may conduct, which may lead to a duplication of effort. Second, although EM's new database has the potential to provide useful historical cost data to cleanup projects developing cost estimates, according to a senior OCA official, it may be challenging to share data between EM's database and OCA's planned historical cost database, representing a missed opportunity for collaboration. According to this OCA official, OCA's database will use a different structure for organizing its data, one that is better suited to DOE's projects. As a result, project teams interested in using information from both databases may find it difficult to gather compatible information from the databases to use in their estimates.

Conclusions

DOE's responsibilities include overseeing billions of dollars worth of environmental cleanup, scientific research, nuclear weapons management, and other mission work vital to the nation's safety, security, and energy supply. Given the task of managing nearly 200 projects expected to cost hundreds of billions of dollars, along with DOE's history of struggling to complete its projects within their cost estimates, obtaining realistic estimates from the contractors carrying out the projects is increasingly critical to inform officials' project management decisions.

However, DOE's lack of both a policy for estimating the costs of projects and current guidance containing best practices to help contractors implement the policy has left the department without the benefit of the internal controls specified in federal standards. More specifically, without a way to ensure that its contractors use best practices in generating cost estimates, and without adequate federal personnel to gauge the quality of the contractors' cost estimates, DOE has effectively ceded a significant portion of its control of this process to its contractors. Further, because DOE's draft cost-estimating policy does not require the department's new independent cost-estimating office—or any other entity within DOE—to conduct ICEs for any projects, including the major projects, at any of the milestones, DOE is not using the most rigorous method available for validating its cost estimates. As a result, some project estimates are likely to continue to lack credibility, and DOE will not have a sound basis for

making decisions on how to most effectively manage its portfolio of projects.

Despite its policy and guidance deficiencies, DOE has taken an important step in recognizing its need for an independent cost-estimating capability. However, by creating a new office, OCA, that has review functions that are similar to those of an office that already exists, DOE has increased the likelihood that duplicative independent review efforts will continue. Further, because OCA reports to the CFO, OCA lacks the independence necessary to dictate its own agenda and remain focused on its core mission and may not be fully able to provide top management with objective determinations. A recent change at DOD serves as a model in this case: at the direction of Congress, DOD provided its centralized, cost-estimating office with greater independence by having it report directly to the Secretary and Deputy Secretary.

Finally, because the cost estimates of the four projects we reviewed were not high quality, the projects are more likely to exceed their estimates, similar to DOE's eight major construction projects that, as we recently reported, exceeded their initial estimates by a total of nearly $14 billion, and DOE's nine major cleanup projects that exceeded their initial estimates by $25 billion to $42 billion. Without better estimates of what construction and cleanup projects will cost, neither DOE nor Congress has reliable information for supporting funding decisions at all stages of the department's project life cycles. Moreover, given the shortcomings of the four cost estimates we reviewed, we are concerned that DOE's cost estimates for its remaining major construction projects and major environmental cleanup projects—which represent tens of billions of dollars combined—have the potential to be similarly problematic. If this is the case, DOE may have greatly miscalculated the amount of funding it will require to complete its portfolio of projects

Recommendations for Executive Action

To better ensure that DOE is able to develop high-quality project cost estimates, we are making the following six recommendations.

First, we recommend that the Secretary of Energy issue the department's forthcoming cost-estimating policy and updated guidance as soon as possible, ensuring that

- the policy requires DOE and its contractors to generate cost estimates in accordance with best practices;

- the policy requires that ICEs be conducted for major projects at milestones 1, 2, and 3; and
- the guidance fully reflects best practices.

In addition, to minimize duplication of effort and promote the independence of the cost-estimating review process, we recommend that the Secretary of Energy

- create a centralized cost-estimating capability by combining the functions that OCA and OECM have in common; and
- consider the structure recently adopted by the Department of Defense, under which its independent cost-estimating office reports directly to the Secretary and Deputy Secretary.

Finally, given the limitations of the cost estimates of the four projects we reviewed, we recommend that the Secretary of Energy direct OCA to conduct an ICE for each major project that has not received one, including three of the four projects we reviewed, all major projects that have not yet started construction or operations, and all future major projects.

Agency Comments and Our Evaluation

In commenting on a draft of this report, the Deputy Secretary of Energy said that DOE concurs with our recommendations in general. However, DOE did not fully concur with two of our recommendations: to require ICEs for major projects at milestones 1, 2, and 3 and to conduct an ICE for each major project that has not received one.

Specifically, regarding requiring ICEs for major projects at milestones 1, 2, and 3, DOE said that the department's new independent cost-estimating policy will require ICEs for these projects at milestones 1 and 2 but that the department does not intend to require ICEs at milestone 3 unless "warranted by risk and performance indicators or required by senior officials." DOE provided no reason for treating milestone 3 differently from milestones 1 and 2. We continue to believe that requiring ICEs at all three milestones is important. According to cost-estimating best practices, conducting an ICE at major milestones, such as milestone 3, is critical because it provides an independent check—and thus a more objective assessment—of the project team's cost estimate. In particular, because DOE projects generate a new or updated cost estimate for milestone 3, which is the final approval milestone before construction or cleanup operations begin, it is essential to cross-check a project team's updated

estimate with a new or updated ICE to help ensure the estimate's credibility.

In addition, DOE only partially agreed with our recommendation to conduct ICEs for all major projects that have not received one, including for three of the four projects we reviewed—National Synchrotron Light Source-II, the Uranium Processing Facility, and EM Cleanup at Y-12. We have two concerns about DOE's response to this recommendation. First, although DOE said it will conduct an ICE for the Uranium Processing Facility before it reaches milestone 2, the agency noted that since both National Synchrotron Light Source-II and EM Cleanup at Y-12 have passed milestone 3, it will conduct ICEs for these projects only if they encounter significant performance issues. We believe, however, that checking these two projects' most recent cost estimates by conducting ICEs is both warranted and important and would improve the credibility of their cost estimates.

Second, although the scope of our recommendation is broader than the three projects we reviewed that have not received an ICE, DOE did not address an important component of our recommendation: that DOE should conduct ICEs for "each major project that has not received one." As a result, it is not clear whether DOE intends to immediately begin conducting ICEs for all major projects already under development that have not yet started construction or operations as well as all future major projects. We have amended our recommendation to clarify the need to conduct these additional ICEs—without waiting until the department has passed its new cost-estimating policy. Moreover, given DOE's statement that it does not intend to require ICEs at milestone 3, we reiterate that our recommendations include conducting ICEs for all major projects at all three milestones.

In addition, although DOE agreed with our recommendation to issue its forthcoming cost-estimating policy and guidance in accordance with best practices, we have two concerns. First, DOE did not state when it plans on issuing the policy and guidance. We believe DOE should issue the policy and guidance as soon as possible since they are already more than a year overdue. Second, DOE did not indicate whether it intends to require that its contractors generate cost estimates in accordance with the department's new guidance and the best practices contained therein, as we recommended. We are concerned that, without this requirement, DOE's contractors may continue to develop project cost estimates according to their own individual policies, as they did at the four projects we reviewed—undermining a DOE-defined, standard approach to cost

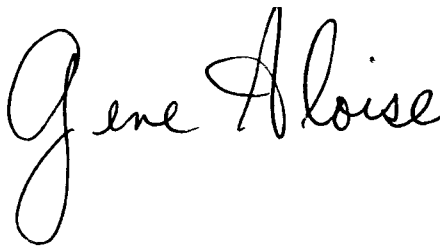
estimating. Although having an updated DOE cost-estimating guide in effect is critical for establishing a standard method for generating and evaluating cost estimates, its impact will be limited unless the department ensures that its contractors generate project cost estimates based on the standard set forth within the guide.

Finally, in responding to our recommendations that DOE create a centralized cost-estimating capability and consider the organizational structure adopted by the Department of Defense, DOE agreed. However, the department did not address whether it will do so by combining the functions that OCA and OECM have in common, as we recommend. It is unclear whether DOE plans instead to implement its draft memorandum of understanding between the two offices without combining their functions—a decision that would not meet cost-estimating best practices.

In addition to its written comments, which are reprinted in appendix IV, DOE provided detailed technical comments, which we incorporated as appropriate.

We are sending copies of this report to other interested congressional committees and to the Secretary of Energy. The report will also be available at no charge on the GAO Web site at http://www.gao.gov.

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



Gene Aloise
Director, Natural Resources
and Environment

Appendix I: Scope and Methodology

To determine the extent to which the Department of Energy's (DOE) cost-estimating policies and guidance support the development of high-quality cost estimates, we analyzed policies and guidance in effect across the department containing specifics on cost estimating. We then compared them with the best practices identified in our cost guide[1] and identified differences. We also interviewed several DOE project directors and asked them to identify the policies and guidance they provided to their contractors before the contractors created the projects' cost estimates in addition to the policies and guidance the project directors followed in overseeing the contractors' estimating work.

To determine the extent to which selected cost estimates reflected the four key characteristics of high-quality cost estimates—credible, well-documented, accurate, and comprehensive—we chose three major construction projects—the Office of Science's (Science) National Synchrotron Light Source-II at Brookhaven National Laboratory in New York, the National Nuclear Security Administration's (NNSA) Uranium Processing Facility at Y-12 National Security Complex in Tennessee, and the Office of Environmental Management's (EM) Salt Waste Processing Facility at the Savannah River Site in South Carolina—and one environmental cleanup project, EM's decontamination and decommissioning project for the Y-12 National Security Complex in Tennessee (EM Cleanup at Y-12), to include in our review. We selected these projects because they require a significant commitment of resources by DOE, were at different stages in the milestone approval process, and were managed by different program offices. We then analyzed the supporting documents related to each project's most recently approved total project cost estimate. These documents included independent review reports, risk analysis outputs, project execution plans, summaries of project assumptions, and design and technical documents. We visited each site, and while there, interviewed DOE project managers and contractor officials about the process used to prepare the cost estimates. We shared our cost guide and the criteria against which we would be evaluating the projects' cost estimates with DOE officials. We then compared DOE's methods and approaches for preparing the estimates with the best practices contained in our cost guide.

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

To assess the actions DOE has taken recently to improve its cost estimating, we analyzed documentation of proposed and recently implemented actions at the department level and at EM, NNSA, and Science and evaluated these actions against the best practices found in our cost-estimating guide. This documentation included DOE's proposed new cost-estimating policy, Order 415, as drafted by the Office of Cost Analysis (OCA), as well as draft guidance on cost estimating. At the program offices, we reviewed NNSA's Independent Cost Estimate Policy and EM's Cost Estimating Strategy. In addition, we interviewed department-level officials from the Office of the Chief Financial Officer, OCA, and Office of Management, including officials from the Office of Engineering and Construction Management and the Office of Procurement and Assistance Management, as well as various officials within EM, NNSA, and Science to obtain their perspective on efforts being taken to improve cost estimating. We also interviewed officials with the Energy Facility Contractors Group, an organization of DOE contractors, to obtain their perspective on DOE's proposed actions to enhance cost estimating. Finally, to further inform our assessment, we reviewed recently passed legislation—the Weapons Systems Acquisition Reform Act of 2009—that includes direction intended to improve cost estimating at the Department of Defense (DOD) by making changes to the structure and function of the Cost Analysis Improvement Group, DOD's cost estimating office, and interviewed that office's director.

We conducted this performance audit from September 2008 to January 2010, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Four Characteristics of a High-Quality Cost Estimate with Their Corresponding 12 Key Cost-Estimating Steps

Characteristic	Step
Credible	• Develop the point estimate and compare it to an independent cost estimate[a] • Conduct sensitivity analysis • Conduct risk and uncertainty analysis
Well-documented	• Define the estimate's purpose, scope, and schedule • Define the program • Identify ground rules and assumptions • Obtain the data • Document the estimate • Present the estimate to management
Accurate	• Develop the point estimate and compare it to an independent cost estimate • Update the estimate to reflect actual costs and changes
Comprehensive	• Develop the estimating plan • Determine the estimating approach

Source: GAO.

[a]This step applies to two of the characteristics—credibility and accuracy.

Appendix III: Assessments of Four Project Cost Estimates Reviewed

This appendix provides a project-by-project assessment of the four DOE project cost estimates we reviewed in detail. Each assessment provides

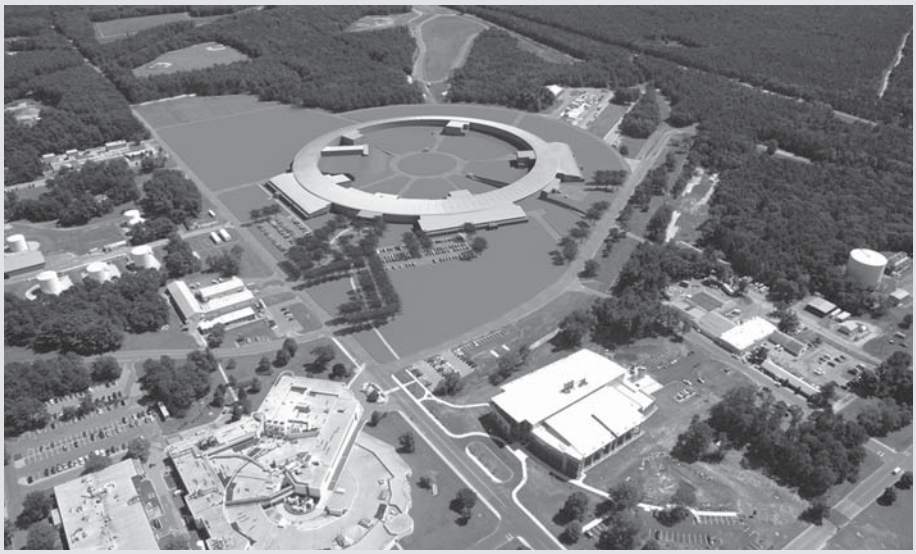
- a brief description of the project's mission;
- project facts, including the cost estimate we reviewed and the status of the project—the milestone, or "Critical Decision" (CD) point, most recently approved; and
- our analysis of the extent to which the project's cost-estimating processes and methodologies included the 12 key steps necessary for preparing high-quality cost estimates, and some key examples of the rationale behind our analysis.

National Synchrotron Light Source–II

Office of Science
Brookhaven National Laboratory, New York

National Synchrotron Light Source (NSLS)-II is a next generation electron synchrotron light source intended to replace the current, 27-year-old NSLS-I facility. It is designed to deliver ultra-high brightness radiation—10,000 times brighter than NSLS-I—and will help meet the nation's need for a high brightness, medium energy X-ray source. The Office of Science intends for the light source to serve a large and diverse scientific user community, including nanoscale imaging for energy, biology, medicine, chemical, and environmental research.

Figure 2: National Synchrotron Light Source–II



Project facts

- **Total Project Cost:** $912 million.
- **Status:** Critical Decision 3 approved on January 9, 2009; construction is scheduled to be completed in fiscal year 2015.

Project timeline

Source: DOE.

Table 2: Cost-Estimating Criteria for NSLS-II

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Well documented			●			
1. Define the estimate's purpose			●			Estimate was prepared at a very low level of detail, consistent with the level of design maturity of one part of the estimate, but not others, including the accelerator and experimental systems. Also, personnel contributing to the estimate lacked significant cost analysis experience and there was little experienced supervision available to assist.
3. Define the program		●				Technical baseline is sufficiently addressed in documentation, but is documented across many documents rather than one single document. Additionally, there was a lack of traceability from quantitative information contained within the technical documents to the cost estimate documentation provided for the CD-3 milestone.
5. Identify ground rules and assumptions			●			Ground rules and assumptions were documented; however they lacked thorough rationale; source; and traceability to specific work breakdown structure (WBS) elements, cost estimate documentation, and risk analysis models.
6. Obtain the data			●			As the foundation of the estimate, little data were gathered from historical data sources; only 12 percent of the total project cost was based on these data. The remainder of the estimate was based on professional judgment, vendor quotes, and catalog prices. For portions of the estimate not based on historical data, the data used were not subjected to validation checks.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
10. Document the estimate				●		The cost estimate documentation outlines the buildup of cost in a logical format and is stored in an electronic, collaborative format that is accessible by authorized personnel. However, it insufficiently describes the underlying data and basis for the calculation used; lacks narrative for describing the cost estimate process, data sources, and methods; and does not document linkages to technical baseline documentation.
11. Present the estimate to management			●			The project team briefed management, but only at a high level, atypical of the content usually presented to management. In addition, the briefing did not provide all assumptions and methodologies and did not address cost drivers.
Comprehensive			●			
2. Develop the estimating plan			●			The estimating plan lacked the detail to address specific cost-estimating tasks. While most of the team responsible for generating the cost estimate inputs has significant technical experience in their assigned project areas, they lacked significant experience in cost estimating and were not from a centralized cost-estimating organization.
4. Determine the estimating approach		●				The estimate is generally structured well, employing a product-oriented WBS. However, the WBS dictionary lacks the detail necessary to describe the resources and functional activities required to produce each element.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Accurate				●		
7. Develop the point estimate and compare to an independent cost estimate[a]				●		The point estimate relied largely on expert opinion as the basis of the estimate. The estimate lacked the use of statistical techniques and cost-estimating relationships. While the point estimate was aggregated logically according to the WBS, no references that relate the results to cross-checks or accuracy checks were found.
12. Update the estimate to reflect actual costs and changes				●		The project team did not update the point estimate to reflect actual costs and changes, and did not document lessons learned.
Credible				●		
7. Develop the point estimate and compare to an independent cost estimate				●		Although the estimate received independent project reviews and two independent cost estimates (ICE) for the conventional facilities, the ICEs only covered a portion of the overall project estimate and were not developed outside the project approval chain. DOE did not perform a project-level ICE.
8. Conduct sensitivity analysis				●		Although a sensitivity analysis was conducted, it did not assess effects of changing discrete performance, physical, or programmatic parameters, preventing the analysis of design changes. The sensitivity analysis did not follow the typical steps for preparing a credible sensitivity analysis, and as a result does not provide a range of possible costs or the means for performing what-if analyses.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
9. Conduct risk and uncertainty analysis			●			Although a risk analysis was performed, there was no quantifiable linkage between key cost driver assumptions and factors and the probability of occurrence and impact values. The risk analysis input parameters are subjectively based, lacking any historical basis or statistical derivation. Additionally, the risk analysis fails to consider correlation between cost elements and improperly forecasts risk at the individual WBS element as well as year by year.

Sources: DOE (data), GAO (analysis).

Note: The ratings we used in this analysis are as follows: "Fully" means that the program provided documentation that satisfied the criterion; "Mostly" means that the program provided the majority of the documentation to satisfy the criterion; "Partially" means that the program provided documentation satisfying part of the criterion; "Somewhat" means that the program provided documentation satisfying a minor part of the criterion; and "Not" means that the program did not provide documentation that satisfied the criterion.

[a]This step applies to both accuracy and credibility.

Uranium Processing Facility

National Nuclear Security Administration
Y-12 National Security Complex, Tennessee

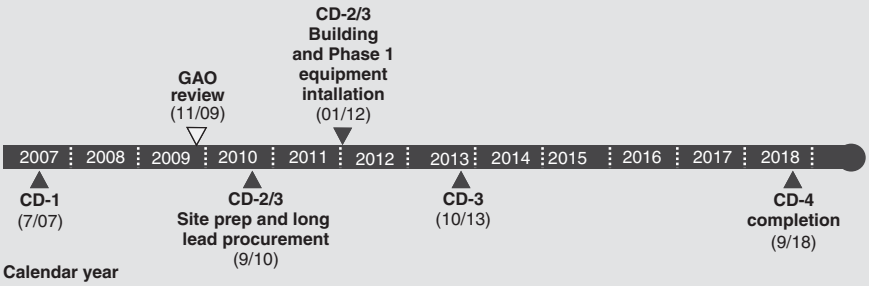
NNSA is planning to build the Uranium Processing Facility in order to ensure the long-term viability, safety, and security of its enriched uranium. The project is expected to consolidate all of NNSA's enriched uranium operations at Y-12 into a single, modern facility with new technologies and safeguards, replacing current operations that are located in deteriorating facilities that do not meet modern safety and security standards. The effort is expected to support the nation's nuclear weapons stockpile and nonproliferation activities, and provide fuel for navy reactors.

Figure 3: Uranium Processing Facility

Project facts

- **Preliminary Cost Range: $**1.4 billion to 3.5 billion.
- **Status:** Critical Decision 1 approved on July 25, 2007; the first of multiple Critical Decision 2 milestones is projected for September 2010.

Project timeline



Source: DOE.

Table 3: Cost-Estimating Criteria for Uranium Processing Facility

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Well documented			●			
1. Define the estimate's purpose		●				Project clearly defined the estimate's purpose, but the level of detail at which the estimate was conducted was not consistent with available design of the project.
3. Define the program		●				The typical elements found in a technical baseline were addressed by multiple documents; however, it is not clear what key portions of the technical baseline were reflected in the estimate.
5. Identify ground rules and assumptions			●			Although the project published a document listing key assumptions, no rationales or backup data were provided, nor was there a clear trace of specific assumptions to the underlying estimate.
6. Obtain the data				●		The foundation of the estimate was not based on data from primary sources and the estimate of total number of design documents and design labor hours was based on professional judgment. However, estimators had access to a commercial construction cost database and historical costs from a contractor who had done work at the site in the past.
10. Document the estimate			●			There is no step-by-step centralized document that ties together the underlying input data used to construct the estimate along with the estimating methodology utilized. It would be very difficult for an analyst unfamiliar with the project to replicate the estimate.
11. Present the estimate to management			●			The formal presentation provided to DOE management contained a summary of the cost estimate that was not detailed—for example, it did not address cost drivers or contain information on the confidence levels associated with the estimate.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Comprehensive			●			
2. Develop the estimating plan			●			Contractor's cost estimators were from a centralized cost-estimating group, however, cost estimate documentation stated the team of 30-40 people who worked on the estimate included two certified cost consultants, a certified cost engineer, and 8-10 estimators. It was not clear who was an experienced and trained cost analyst.
4. Determine the estimating approach		●				The WBS appeared to contain all work that needs to be done to complete the project with the exception of technology development costs; but it was not based on a standard WBS.
Accurate				●		
7. Develop the point estimate and compare to an independent cost estimate[a]				●		Contractor did not employ various cost-estimating methods, but rather relied solely on a detailed, bottoms-up method. Contractor's estimating system was very detailed and did not lend itself to a more top-down, statistical approach.
12. Update the estimate to reflect actual costs and changes				●		Since approval of CD-1, the contractor is collecting performance data on the design portion of the project's life cycle, but no one is tracking the effect of this performance on total project cost. Estimate will not be updated until CD-2.
Credible				●		
7. Develop the point estimate and compare to an independent cost estimate				●		Project did not receive an ICE; NNSA conducted a technical independent review, which included examining costs. The project team cross-checked the estimate with data from other projects, although those data reflected estimated costs, not actual costs.
8. Conduct sensitivity analysis					●	Project team did not conduct a sensitivity analysis.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
9. Conduct risk and uncertainty analysis			●			Project team conducted a risk analysis that examined technical and programmatic, cost, and schedule risk to the project; however, this risk analysis did not account for correlation between cost elements. Separate from the risk analysis, NNSA headquarters added an additional $1.1 billion unfunded "programmatic allowance" to the upper end of the cost range to account for additional risks not incorporated in the analysis.

Sources: DOE (data), GAO (analysis).

Note: The ratings we used in this analysis are as follows: "Fully" means that the program provided documentation that satisfied the criterion; "Mostly" means that the program provided the majority of the documentation to satisfy the criterion; "Partially" means that the program provided documentation satisfying part of the criterion; "Somewhat" means that the program provided documentation satisfying a minor part of the criterion; and "Not" means that the program did not provide documentation that satisfied the criterion.

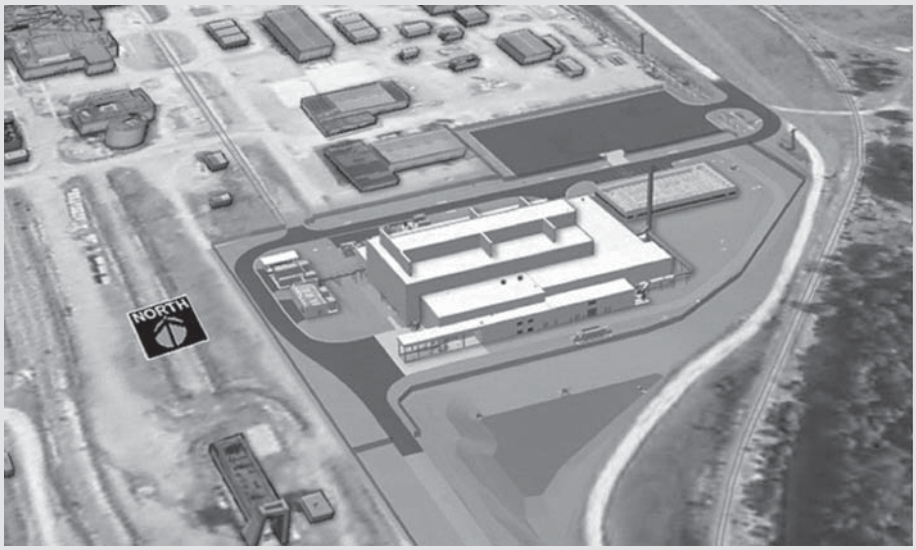
[a]This step applies to both accuracy and credibility.

Salt Waste Processing Facility

Office of Environmental Management
Savannah River Site, South Carolina

This project will construct a facility to treat large quantities of waste from reprocessing and other liquids generated by nuclear materials production operations at the Savannah River site, converting it into a stable form for eventual disposal in a geological repository. Approximately 37 million gallons of this waste are being stored on an interim basis in 49 underground storage tanks at the site—of this, about 34 million gallons are salt waste slated for treatment at the new facility.

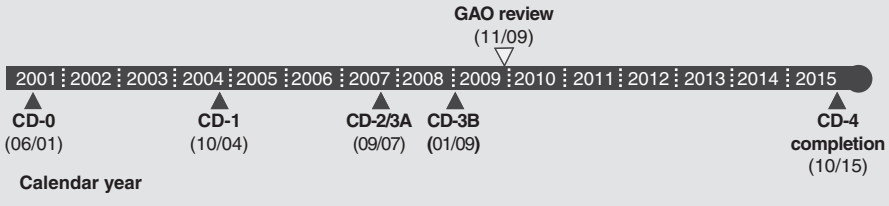
Figure 4: Salt Waste Processing Facility



Project facts

- **Total Project Cost:** $1.34 billion.
- **Status:** Critical Decision 3 approved on January 2, 2009; construction is expected to be completed in October 2015.

Project timeline



Source: DOE.

Table 4: Cost-Estimating Criteria for Salt Waste Processing Facility

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Well documented			●			
1. Define the estimate's purpose		●				Although the estimate and scope were clearly defined and based on a bottoms-up review, it is not clear that there was enough time or resources to develop and review the estimate.
3. Define the program		●				Although the contractor supplied several documents that appear to sufficiently address the technical baseline, the contractor did not fully demonstrate that the technical baseline was developed by qualified personnel. Furthermore, it was not possible to evaluate the technical baseline because underlying data used to develop the cost estimate were not provided.
5. Identify ground rules and assumptions		●				Although the estimate defines and documents most of the ground rules and assumptions it makes, it does not provide the historical data for some of its key assumptions to back up claims. In addition, although the schedule is assessed for impacts, the estimate does not model schedule activity uncertainties.
6. Obtain the data				●		Although the contractor claims that historical data were used to develop the estimate, historical cost data and data from other technical sources were not provided. As a result, we could not analyze the data to determine whether they were reasonable.
10. Document the estimate				●		The estimate insufficiently describes the underlying data and bases for the calculations used. As a result, we could not analyze data to determine whether they contain elements of a high-quality estimate.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
11. Present the estimate to management			●			The project team briefed management, and obtained DOE approval to continue the project; however, the briefing was at a high level and did not provide detailed information about assumptions or methodologies.
Comprehensive			●			
2. Develop the estimating plan			●			The estimating approach and schedule is documented, however, it is not clear that team members are from a centralized cost-estimating group or have the proper experience or access to subject area experts knowledgeable about large, complex nuclear construction projects of the scale and complexity of this facility.
4. Determine the estimating approach		●				Although the estimate has a WBS, it is only partially product oriented with product-oriented structures embedded in a functionally oriented structure.
Accurate			●			
7. Develop the point estimate and compare to an independent cost estimate[a]			●			It is not clear what estimation methodologies were used because there were few details about methodology and no supporting data.
12. Update the estimate to reflect actual costs and changes		●				The project team had a process for updating the estimate, and updated the point estimate to reflect actual costs and changes, but did not document lessons learned.
Credible				●		
7. Develop the point estimate and compare to an independent cost estimate			●			OCA performed an independent cost estimate at the request of the Deputy Secretary of Energy, resulting in an estimate of $2.7 billion–more than twice as high as the project team's estimate. However, no formal reconciliation process occurred between OCA and the project team to determine where and why there were differences in their estimates.
8. Conduct sensitivity analysis					●	The contractor did not conduct a sensitivity analysis.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
9. Conduct risk and uncertainty analysis			●			Although a risk and uncertainty analysis was performed and cost drivers were identified, the correlation between cost elements was not accounted for, and the probability associated with the point estimate was not identified. In addition, an S-curve of alternative cost estimate probabilities was not provided.

Sources: DOE (data), GAO (analysis).

Note: The ratings we used in this analysis are as follows: "Fully" means that the program provided documentation that satisfied the criterion; "Mostly" means that the program provided the majority of the documentation to satisfy the criterion; "Partially" means that the program provided documentation satisfying part of the criterion; "Somewhat" means that the program provided documentation satisfying a minor part of the criterion; and "Not" means that the program did not provide documentation that satisfied the criterion.

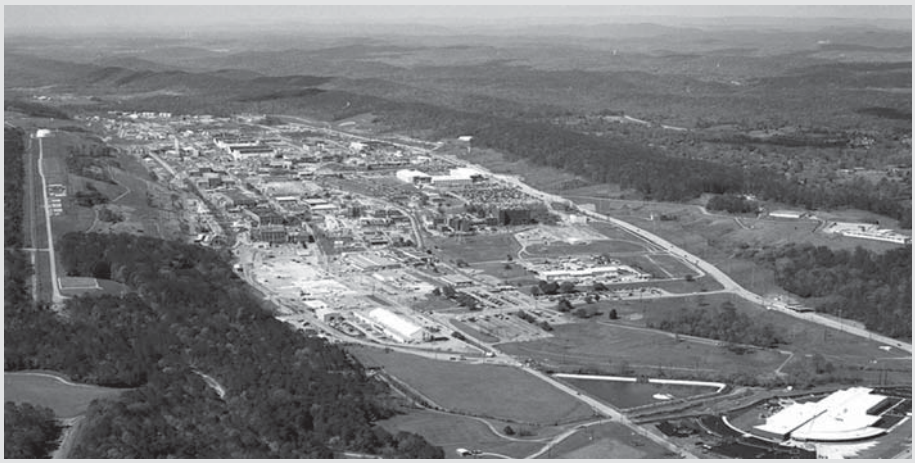
[a]This step applies to both accuracy and credibility.

Nuclear Facility Decontamination and Decommissioning at Y-12 (EM Cleanup at Y-12)

Office of Environmental Management
Y-12 National Security Complex, Tennessee

This project involves the cleanup of the Y-12 National Security Complex, a significant source of environmental contamination. Specifically, it includes construction and operation of on-site landfills and the Environmental Management Waste Facility disposal facility; decontamination and decommissioning of contaminated facilities, including the Alpha 4 Facility; soil, sediment, scrap, and burial ground remediation; and environmental monitoring of soils and water sources to assess the effectiveness of cleanup actions. Much of the project's scope will be transferred to EM's Integrated Facility Disposition Project, a large project encompassing decontamination and decommissioning and remediation of soil and groundwater at Y-12 and the neighboring Oak Ridge National Laboratory.

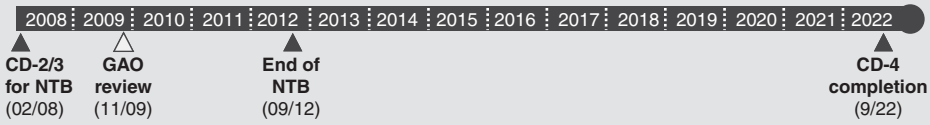
Figure 5: EM Cleanup at Y-12



Project facts

- **Near-term Baseline (NTB)**: $338 million.
- **Total life cycle cost:** $1.1 to 1.2 billion.
- **Status:** Critical Decision 2/3 approved on February 13, 2008; NTB period is from fiscal year 2008-2012.

Project timeline



Source: DOE.

Table 5: Cost-Estimating Criteria for EM Cleanup at Y-12

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
Well documented			●			
1. Define the estimate's purpose	●					Fully meets all assessment criteria.
3. Define the program		●				The technical baseline exists and is updated as changes become known, and it was mostly developed by qualified personnel. However, the baseline provided was only at a summary level.
5. Identify ground rules and assumptions			●			Although the estimate defines and documents the ground rules and assumptions, there is no evidence that they have been approved by upper management and there is no rationale provided to support some of the assumptions.
6. Obtain the data			●			The data used to prepare the cost estimates were based on conceptual design as well as actual data, historical data, quotes from vendors, expert opinion, and experience. However the program was not able to provide documentation regarding the source of the data used.
10. Document the estimate			●			The program has formal documentation books for each cost element. These books contain technical and programmatic information. While the books contain the methodology used to create the estimate, only some examples of the data sources used were provided.
11. Present the estimate to management			●			The program held a formal briefing in January 2008. The briefing contains summary information about the project but does not contain detailed information about the cost estimate methodology.
Comprehensive		●				
2. Develop the estimating plan		●				The cost estimators who developed the cost estimates are qualified estimators. However there was no schedule developed for creating the estimate.

Four characteristics of high-quality cost estimates and 12 key steps	Fully met	Mostly met	Partially met	Somewhat met	Not met	Key examples of rationale for assessment
4. Determine the estimating approach		●				The program has a WBS that is product oriented and reflects all work that needs to be accomplished. However the agency does not have a standardized WBS.
Accurate			●			
7. Develop the point estimate and compare to an independent cost estimate[a]			●			A variety of cost-estimating methodologies were used to develop the cost estimate. However, limited statistical testing was done on the underlying data.
12. Update the estimate to reflect actual costs and changes		●				Cost estimates are updated for major events such as when a new contractor is selected, at the end of the near-term baseline, or if a major funding change is approved. The program does not have a formal process for capturing lessons learned.
Credible				●		
7. Develop the point estimate and compare to an independent cost estimate				●		In November 2007, an independent assessment was performed. The independent assessment only reviewed a selected portion of the project and is typically used to validate the technical approach.
8. Conduct sensitivity analysis				●		A sensitivity analysis was not performed. However, the project does consider variations in cost elements.
9. Conduct risk and uncertainty analysis			●			Although a risk analysis was performed, the analysis did not address correlation. Also, the documentation and rationale behind the risk analysis were not provided.

Sources: DOE (data), GAO (analysis)

Note: The ratings we used in this analysis are as follows: “Fully” means that the program provided documentation that satisfied the criterion; “Mostly” means that the program provided the majority of the documentation to satisfy the criterion; “Partially” means that the program provided documentation satisfying part of the criterion; “Somewhat” means that the program provided documentation satisfying a minor part of the criterion; and “Not” means that the program did not provide documentation that satisfied the criterion.

[a]This step applies to both accuracy and credibility.

Appendix IV: Comments from the Department of Energy

The Deputy Secretary of Energy
Washington, DC 20585

December 17, 2009

Mr. Gene Aloise
Director, Natural Resources and Environment
Government Accountability Office
Washington, DC 20548

Dear Mr. Aloise:

Thank you for the opportunity to comment on your draft report on the Department of Energy's (DOE) cost estimating function, *Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects*. While the Department's high-risk, unique projects make the development of accurate cost estimates particularly challenging, DOE is committed to improving its cost estimating capability.

The Department has begun several initiatives to improve cost estimating practices as a result of its Corrective Action Plan for contract and project management issues. These include development of a DOE-wide cost database, additional training courses, and development of policies and guidance relating to independent cost estimates.

DOE program offices and the National Nuclear Security Administration (NNSA) have made substantial progress towards improving their cost estimates. NNSA established a policy to require independent cost estimates when appropriate. The Office of Environmental Management established the Office of Cost Estimating and Analysis within its Consolidated Business Center and is developing a historical cost database to facilitate and improve cost estimates.

While the Department concurs with GAO's recommendations in general, specific responses to the report recommendations are enclosed. Also, we are submitting technical and factual comments for your consideration in preparing the final report.

Sincerely yours,

Daniel B. Poneman

Enclosures: Response to recommendations
Departmental and NNSA technical and factual comments

(Enclosure)

U. S. Department of Energy
GAO-10-199 – *"DEPARTMENT OF ENERGY: Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects"*

Response to GAO Recommendations for Executive Action

Recommendation 1: **The Secretary of Energy should issue the department's forthcoming cost estimating policy and guidance as soon as possible to ensure that DOE and its contractors generate cost estimates in accordance with best practices.**

DOE Response The Department concurs with GAO's recommendation. DOE will issue its updated policy, requirements and guidance in the revision to DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets*, Order 415.X, *Cost Estimating for DOE Programs and Projects* and companion Guides. The policy and guidance documents will reflect best practices noted by GAO in its Cost Estimating and Assessment Guide. Additionally, the policy and guidance documents will clarify roles and responsibilities for cost estimating and assessment within the Department.

Recommendation 2: **The Department's forthcoming cost-estimating policy and guidance should require that independent cost estimates be conducted for major projects at milestones 1, 2, and 3.**
(Note: Milestones 1, 2, and 3, as defined by GAO, refer to Alternative Selection and Cost Range, Performance Baseline, and Start of Construction, respectively)

DOE Response: The Department partially concurs with GAO's recommendation. The Department's pending cost estimating order (415.X) will require independent cost estimates for major projects prior to approval of Alternative Selection and Performance Baseline (milestones 1 and 2). These independent cost estimates will be consistent with the project phase. For milestone 1, the Department will identify a cost range using parametric cost methods (or extrapolation from actual costs for similar projects when available). For milestone 3—start of construction—DOE will conduct an independent cost estimate if warranted by risk and performance indicators or required by senior officials.

Recommendation 3: **To minimize duplication of effort and promote the independence of the cost-estimating review process, GAO recommends that the Secretary of Energy create a centralized cost-estimating capability by combining the functions that the Office of Cost Analysis (OCA) and the Office of Engineering and Construction Management (OECM) have in common. In centralizing the cost estimating functions in one office, GAO recommends that the Secretary consider the organizational structure recently adopted by the Department of Defense (DOD), where the cost-estimating office reports directly to the Secretary and Deputy Secretary.**

DOE Response: The Department concurs with GAO's recommendation. DOE will centralize its cost estimating functions and will consider the organizational structure adopted by the Department of Defense. Specific organizational roles and responsibilities will be defined in the Department's pending cost estimating order.

Recommendation 4: **The Secretary of Energy should direct the Office of Cost Analysis to conduct an independent cost estimate for each major project that has not received one, including three of the four projects that GAO reviewed** *(Note. The three projects refer to the National Synchrotron Light Source II (NSLS II), Uranium Processing Facility (UPF), and EM Cleanup at Y-12).*

DOE Response: The Department partially concurs with GAO's recommendation. The Department will conduct independent cost estimates for the projects reviewed by GAO as appropriate for the next project milestone. This is consistent with GAO's prior recommendation to conduct independent cost estimates at project milestones 1, 2, and 3. Regarding the specific projects identified by GAO:

- UPF: The Department will perform an independent cost estimate for this project prior to establishing the Performance Baseline (anticipated in mid to late 2010).
- NSLS-II: This project has started construction. The Department will continue to monitor cost, schedule and performance for this project on a quarterly basis, and will perform an independent cost estimate only if there are significant performance issues.
- Y-12: This project has started remediation. As with NSLS-II, the Department will evaluate performance of this project and will only perform an independent cost estimate if there are significant performance issues.

Additionally, for the Salt Waste Processing Facility project reviewed by GAO, the Department will continue to monitor cost, schedule and performance for this project on a quarterly basis, and will perform an independent cost estimate only if a performance baseline change is required.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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

Staff Acknowledgments

In addition to the individual named above, Daniel Feehan, Assistant Director; Brian Bothwell; Rudy Chatlos; Nancy Crothers; Tisha Derricotte; Jennifer Echard; Mike Gallo; Kristen Massey; Brian Octeau; Cheryl Peterson; Leslie Kaas Pollock; and Jacqueline Wade made key contributions to this report.

GAO's Mission

The Government Accountability 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 GAO's Web site (www.gao.gov). Each weekday afternoon, GAO posts on its Web site newly released reports, testimony, and correspondence. To have GAO e-mail you a list of newly posted products, go to www.gao.gov and select "E-mail Updates."

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's Web site, http://www.gao.gov/ordering.htm.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

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

Congressional Relations

Ralph Dawn, Managing Director, dawnr@gao.gov, (202) 512-4400
U.S. Government Accountability Office, 441 G Street NW, Room 7125
Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548